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TITLE: Transmission control system using road data to control the transmission

Brief Summary Text (5):
In recent years, there is mounted on an ordinary vehicle a navigation system. This navigation system is constructed such that a map is held as electronic data in a memory medium such as CD-ROM whereas the position of the vehicle is located by the GPS (Global Positioning System) using an

Brief Summary Text (6):
artificial satellite or the self-contained navigation (or dead reckoning method). These data are combined to output the present position or moving locus of the vehicle or a route to be followed, visually in a display unit such as the CRT, and to guide the running direction in voices.

Brief Summary Text (7):
The electronic map to be used in the navigation system can be stored not only the data such as the layout of roads, the public facilities or the rivers but also the slopes of roads or the legal regulations on road traffics and further a variety of road data such as the coefficients of friction of road surfaces, as achieved by the actual runs. As a result, the data to be obtained by the navigation system can be used not only to guide the vehicle to a destination but also to control the engine, the transmission, the brake system and the body suspension system while the vehicle is running.

Brief Summary Text (8):
One example is disclosed in JP-B-6-58141. The system, as disclosed, is constructed to change the shift pattern of the automatic transmission on the basis of the road data of a route to be followed, as achieved by the navigation system. For example: the shift is inhibited when a curve is detected ahead of the vehicle; the overdrive stage is inhibited when a mountainous region is detected; and a predetermined downshift is inhibited when the so-called "low-.mu. road" having a low coefficient of road surface friction is detected.

Brief Summary Text (9):
In JP-A-5-322591, on the other hand, there is disclosed a system which is constructed to change a shift pattern of an automatic transmission in accordance with a road slope, as detected by the navigation system. Specifically, the control system for an automatic transmission, as disclosed in the Laid-Open, comprises: running state detecting means for detecting the running state of a vehicle; a navigation system for detecting the data of a road ahead of the vehicle, the running azimuth of the vehicle and the present position of the vehicle; and control means for changing the shift pattern (or the shift diagram) of the automatic transmission into such one for a slope as is adapted for the slope of the road.

Brief Summary Text (11):
In the prior art, however, the system is constructed, as described above, such that the vehicle is controlled according to the individual road data on the route to be followed, as detected by the navigation system. As a result, if the road data requiring the so-called "special control" for changing the shift pattern for the upslope/downslope or the curved road are frequently detected, the hunting may occur to

repeat the shift, and still the worse the drivability may be deteriorated. In the prior art, on the other hand, the shift pattern may be changed according to the actual running state, or the running control characteristics may be set to predetermined ones by the manual operations. However, the prior art has taken no consideration into the control of the case in which that control interferes with the control based on the data obtained by the navigation system. As a result, the power performance of the vehicle may become different from the intention of the driver to cause a discomfort.

Brief Summary Text (23):
According to the control system having the construction of a ninth feature of the present invention, if a flat road between upslopes/downslopes or an upslope/downslope between flat roads is short or passed for a short time, the shift control is executed by the shift pattern just before. Specifically, if the flat road is short, the shift pattern, which is liable to set a higher gear ratio for the upslope/downslope control, is used for the shift control. If the flat road is long or if the upslope/downslope is short, on the contrary, the basic shift pattern to be used for an ordinary flat road is adopted for the shift control. As a result, if the shift pattern is changed and if it is decided that the running distance or time for the changed shift pattern is short, the shift pattern is not changed. As a result, the shifting frequency, as accompanying the change in the shift pattern, is lowered to improve the drivability.

Drawing Description Text (3):
FIG. 2 is a block diagram showing an example of the construction of a navigation system;

Detailed Description Text (6):
The hydraulic control unit 12 is composed of a regulator valve for regulating the pressure, a shift valve for applying/releasing the lockup clutch or executing the speed change, and a plurality of solenoid valves (although not shown) for outputting signal pressures to those valves. There is further provided an automatic transmission electronic control unit (T-ECU) 13 for controlling the automatic transmission 2 indirectly by outputting electric signals to those solenoid valves. To the automatic transmission 2, moreover, there are attached sensors including a sensor for detecting the input RPM of the transmission, a sensor for detecting an output shaft RPM, and a sensor for detecting the oil temperature, although not especially shown.

Detailed Description Text (7):
The aforementioned electronic control unit 13 is constructed, like the foregoing engine electronic control unit 10, mainly of a microcomputer for deciding the gear stage on the basis of not only the input signals of a throttle opening, a vehicle speed, an oil temperature, a shift position, a shift pattern, a driving tendency, a road slope and a brake signal but also a shift pattern or a shift diagram stored in advance. Moreover, the electronic control unit 13 controls the lockup clutch, in accordance with the running state judged from the data inputted, and the line pressure in accordance with the throttle opening. Incidentally, those individual electronic control units 10 and 13 are connected to communicate with each other while exchanging the data. As a result, the data necessary for the controls are inputted from a predetermined sensor to the electronic control units 10 and 13 and are transmitted from one electronic control unit 10 (or 13) to the other 13 (or 10).

Detailed Description Text (12):
The following system is provided for improving the stability, drivability and power performance of the vehicle by feeding the data and the instruction signals to the aforementioned individual electronic control units 10 and 13. Specifically, there is provided a navigation system 20 which has a basic function to guide its carrying vehicle to a predetermined target. This navigation system 20 is equipped, as shown in FIG. 2, with an electronic control unit 21, a first data detecting unit 22, a second data detecting unit 23, a player 24, a display 25 and a speaker 26.

Detailed Description Text (16):
The aforementioned first data detecting unit 22 is used to detect the present position of its carrying vehicle, the road situations and the distances from other vehicles by the self-contained navigation, and is composed of a geomagnetic sensor 30 for detecting the azimuth for driving the vehicle, a gyrocompass 31, and a steering sensor 32 for detecting the steering angle of the steering wheel.

Detailed Description Text (19):
On the other hand, the second data detecting unit 23 detects the present position of its carrying vehicle, the road situations, the other vehicles, the blocks and the weather, and is composed of a GPS antenna 40 for receiving radio waves from an artificial satellite 39, an amplifier 41 connected with the GPS antenna 40, and a GPS receiver 42 connected with the amplifier 41.

Detailed Description Text (21):
Moreover, the GPS receiver 42 and the ground data receiver 46 are so connected with the electronic control unit 21 as to effect the data communications so that the data, as detected by the second data detecting unit, are transferred to the electronic control unit 21.

Detailed Description Text (22):
On the other hand, the display 25 is made of a liquid crystal or a cathode ray tube (CRT) and is given functions: to display the data graphically such as the roads to follow to the destination, the road situations of the followed roads, the present position of its carrying vehicle, the presences and locations of other vehicles, or the presences and locations of blocks; and to display the running modes corresponding to the predetermined sections of the road situations and the shift diagrams to be used for controlling the automatic transmission 2 on the basis of the datas stored in the data recording medium 27 or first and second data detecting unit 22 and 23. Incidentally, the various data are displayed in the display 25 and outputted as voices from the speaker 26.

Detailed Description Text (23):
With the display 25, there are connected a variety of switches 28 and an external input pen 29, which can be operated to control the first data detecting unit 22 or the second data detecting unit 23, to set the destination and the roads to be followed, to set the predetermined sections in the followed roads, to display and set the running modes suited for the road situations of the predetermined sections, and display and change the shift diagram to be applied for controlling the automatic transmission 2.

Detailed Description Text (24):
In the navigation system 20 described above, the data of the roads to be followed, as detected by the first data detecting unit 22, the data of the roads to be followed, as detected by the second data detecting unit 23, and the map data, as stored in the data recording medium 27, are synthetically compared or evaluated to decide the road situations of or around the present position of the vehicle on the route being followed.

Detailed Description Text (25):
Here, detection errors may be caused in the individual sensors when the present position is to be decided on the basis of the data to be detected by the first data detecting unit 22. Therefore, controls are performed to absorb the errors by the map matching method. This map matching method is a control to correct the present position of the vehicle by comparing the running locus of the vehicle, as detected from the signals of the various sensors, and the map data as stored in the data recording medium 27.

Detailed Description Text (30):
The control system having the construction thus far described controls the automatic transmission 2 on the basis of the road data, as obtained from the aforementioned navigation system 20 or by detecting the actual running states. Here will be described examples of the control.

Detailed Description Text (31):
FIG. 3 shows an example of the control at the starting time on a curved road. At first Step 1: the present position of the vehicle is located by the navigation system 20; the present position and the coming road situations are specified; and the control of the automatic transmission 2 is executed by the basic pattern. Here, the present position of the vehicle can be located, as customary, by the aforementioned dead reckoning navigation or GPS. Moreover, the road situations can be specified on the basis of the data, as stored in the navigation system 20, and the data as obtained

from the aforementioned ground data transmission system 43. Incidentally, the road ahead of the present position can be specified by inputting the destination to set the route to be followed. Alternatively, the coming road can be judged from either the route followed just before or the map data. Moreover, the basic shift pattern can be executed as the shift patter by reading the pattern stored as the shift diagram, for example.

Detailed Description Text (41):
Here will be described an example of the control in which the vehicle is braked on a curved road. This control example is shown in FIG. 4. At first, the location of the present position, the specification of the coming road situations, and the control by the basic shift pattern are executed (at Step 11) as at Step 1 in the aforementioned control of FIG. 3. It is then decided (at Step 12) from the road data of the navigation system 20 whether or not a corner is in front of the vehicle, or whether or not the vehicle is cornering. Simultaneously with this, the radius of the corner is detected. If the answer of Step 12 is "YES", it is decided (at Step 13) whether or not the braking operation has been conducted just before the corner, or whether or not the accelerator pedal is returned during the cornering. These decisions can be executed by the predetermined control unit such as the automatic transmission electronic control unit 13. Incidentally, at this Step 13, the magnitude of the braking force at the braking time is also detected. This detection can be decided on the basis of the changing rate of the vehicle speed, that is, the deceleration.

Detailed Description Text (43):
This control of changing the shift pattern can be executed only when the driving tendency is sporty or when a specific running mode such as the sport mode is selected. And, the cornering is executed with the curve shift pattern, and the control routine is returned.

Detailed Description Text (49):
Here will be described the control for an automobile dedicated road. FIG. 5 shows an example of the control, in which a control similar to that of Step 1 of FIG. 3 is executed (at Step 21). Next, it is decided (at Step 22) whether or not the vehicle enters an expressway. If the answer of Step 22 is "YES", it is decided (at Step 23) whether or not the vehicle is to start from the ramp way of the expressway such as the tollgate, the ticket inspection gate or the service area. These decisions can be executed by the navigation system 20.

Detailed Description Text (58):
Next, a control example, in which the coefficient of friction of the road surface is small, will be described with reference to FIG. 6. In FIG. 6, controls similar to those of Step 1 of FIG. 3 are executed at Step 41. By the navigation system 20, moreover, it is decided (at Step 42) from the set content of a destination whether or not the vehicle is running in a cold zone. If the answer of Step 42 is "YES", it is decided (at Step 43) whether or not the ambient temperature is no more than a predetermined value stored in advance, and it is decided on the basis of a calendar stored as electronic data whether or not it is in winter.

Detailed Description Text (61):
It is then decided (at Step 45) whether or not the road has a low coefficient of friction, that is, a frozen state. This decision can be made on the basis of the data stored in advance in the navigation system 20, or the renewable data, or by the anti-lock brake system 50 or the vehicle stability control system 70. If the answer of Step 45 is "YES", the shift pattern for the cold zone is changed to one for the snow mode (or the shift pattern for the low-friction coefficient road) (at Step 46). Incidentally, if it is detected at Step 45 that the road is not the low-friction coefficient road, the control is made as it is with the cold zone shift pattern, and the control routine is returned.

Detailed Description Text (64):
A control example for the vehicle to run in a urban area will be described with reference to FIG. 7. In FIG. 7, at first, controls similar to those of Step 1 of FIG. 3 are executed at Step 51. Next, it is decided (at Step 52) whether or not the vehicle runs in the urban area or whether or not the vehicle has already been running in the urban areas (or residential district). This decision can be executed on the basis of

either the detection result of the present position by the navigation system 20 or the road data. If this answer of Step 52 is "YES", the basic shift pattern is changed to one for the urban area, by which the automatic transmission 2 is controlled (at Step 53), and then the control routine is returned. Here, the shift pattern for the urban area is one, in which the region of the gear stage on a higher speed side having a low gear ratio is expanded to a lower speed side to a larger throttle opening .theta. side.

Detailed Description Text (68):
In FIG. 8, the location of the present position and the situation of the present position and the coming road situations are executed by the navigation system 20 (at Step 61). These controls are similar to the aforementioned ones of Step 1 shown in FIG. 3. Here, the coming road is either a route to be followed to the destination, as inputted to the navigation system 20, or a forward road to be estimated on the basis of the running history to that point.

Detailed Description Text (69):
When the coming road situations are thus specified, it is decided (at Step 62) whether or not a corner (or a curved road) is on a downslope in front of the vehicle. Here, the "front" covers the range which extends from the present position on the route to be followed, as detected by the navigation system 20. Moreover, the "curve" in the present invention covers both the case, in which the road itself is curved (as at an intersection or an ordinary curve), and the curving on the basis of the route to be followed.

Detailed Description Text (72):
When the vehicle advances to a downslope, the downslope control is executed. When a corner is passed or when the downslope ends, the downslope control is ended, and the basic shift pattern is restored (at Step 64). The decision for executing these controls of Step 64 can be made with either the road data, as achieved by the navigation system 20, or the acceleration/or deceleration as detected on the basis of the vehicle speed.

Detailed Description Text (83):
Here will be described another example of the shift control at a corner on an upslope/downslope. FIG. 10 shows an example containing the presence/absence of braking at the corner and the control at the corner exit. At first Step 71, the present position is located, and the road situations ahead of the present position are specified. These operations can be executed as in the aforementioned control of Step 61 of FIG. 8 or 9.

Detailed Description Text (84):
It is then decided whether or not a corner is ahead of the vehicle or whether or not the vehicle is cornering (at Step 72). This decision can be made by the navigation system 20, and the present cornering can be decided on the basis of the input signal coming from the yawing rate sensor or the steering sensor. If this answer of Step 72 is "YES", it is decided (at Step 73) whether or not the brake switch has been turned ON from OFF, that is, whether or not a braking has been executed. This decision can be made on the basis of the signal coming from the brake switch, as inputted to the automatic transmission electronic control unit 13, for example.

Detailed Description Text (86):
If the answer of Step 72 is "NO", on the other hand, it is decided (at Step 75) whether or not the vehicle is at the corner exit. This decision can be made by the navigation system 20. If the answer of Step 75 is "YES", the running resistance is reduced to allow an upshift (at Step 76). This control can be executed either by changing the shift diagram or resetting a control flag for inhibiting the shift. The control routine is then returned. If the answer of Step 73 or Step 75 is "NO", the control by the unchanged shift pattern (i.e., the shift pattern for the downslope control) is executed, and the control routine is returned. Incidentally, the control, as shown in FIG. 10, can be executed not only on a downslope but also on an upslope.

Detailed Description Text (91):
FIG. 11 shows a control example for changing a downslope control in accordance with a straight road between corners or downslopes. At first Step 81, the present position is

located, and the road situations ahead of the present position are specified. These operations can be performed as at Step 61 shown in FIG. 8. Next, on the basis of the road situations specified at Step 81, it is decided (at Step 82) whether or not a corner exit is ahead of the vehicle. If the answer of Step 82 is "YES", the distance to a straight road to a next corner or a next downslope is calculated, and a threshold value for deciding the execution of the downslope control on the basis of the distance of the straight road is calculated (at Step 83). The distance of the straight road can be calculated on the basis of the road data stored in the navigation system 20. Moreover, the calculation of the threshold value, as based upon the former calculation, can be executed by storing the relation of the two in advance as a map and by reading the threshold value corresponding to the calculated distance of the straight road. Incidentally, the threshold value is set, for example, to the higher value (or gradient) for the longer distance of the straight road. In short, the gradient for the downslope control to be executed becomes the larger for the longer straight road.

Detailed Description Text (95):
According to the control shown in FIG. 11, therefore, if the straight road is short, the execution of the downslope control is executed even with a small gradient so that the preceding downslope control is continued. This makes it possible to prevent the troublesome change in the shift pattern and the according troublesome shift (or the hunting or busy shifting).

Detailed Description Text (96):
Here will be described a control example in which the continuation or return (or quit) of the upslope/downslope control is decided on the basis of the time or distance from the present position in place of the control for deciding the execution/inexecution of the downslope control from the distance from the aforementioned corner exit to the next corner or the downslope. FIG. 12 shows a control example on a downslope. First of all, the vehicle is braked, and it is decided (at Step 91) whether or not the distance or time to the downslope is less than a reference value. This decision can be made on the basis of the signal coming from the brake switch, as inputted to the automatic transmission electronic control unit 13, and the road data obtained by the navigation system 20.

Detailed Description Text (97):
If this answer of Step 91 is "YES", a downshift from the highest 4th speed to the 3rd speed is executed, but the upshift to the 4th speed is inhibited (at Step 92). This control can be executed, for example, by changing the shift pattern from the basic one to a shift pattern for the downslope control. On the other hand, the control of Step 92 is one for effecting the engine braking. It is, therefore, preferable to apply the lockup clutch or to control the lockup clutch in a slipping manner. On the other hand, the downshift should not be limited to the 3rd speed but may be extended to the 2nd speed.

Detailed Description Text (99):
In the control example shown in FIG. 12, therefore, the downslope control can be started not only by braking on a downslope but also by changing the shift pattern before the downslope is actually entered, so that it can be executed without delay. If the answer of Step 91 on a flat road between downslopes is "YES", on the other hand, the downshift control can be continued to prevent the busy shifting or hunting.

Detailed Description Text (100):
The aforementioned control shown in FIG. 12 can also be applied to a control on an upslope, as exemplified in FIG. 13. First of all, it is decided (at Step 101) whether or not the vehicle is running at the 1st to 3rd speeds after the power-ON downshift and whether or not the time or distance to the upslope is less than a predetermined value. These decisions can be done as at Step 91 of FIG. 12 by the navigation system 20 and the automatic transmission electronic control unit 13.

Detailed Description Text (101):
If the answer of Step 101 is "YES", an upshift to the 4th speed is inhibited (at Step 102). This inhibition can be executed either by setting the inhibition flag of the 4th speed or by changing the shift pattern to one for the upslope/downslope.

Detailed Description Text (113):
First of all, an decision control of a winding road will be described with reference to FIG. 16. If the road being followed is not a winding road, the terminal point of a straight portion, from which the winding road is possibly begun, that is, the starting point of a curved portion is set as the initial point for searching the winding road. Specifically, for a point P(n) (n=1, 2, - - -) ahead of the present position on the basis of the road data of the navigation system 20, the end point P(iws) is determined as iws if the vehicle is running straight. If the vehicle is running on a curve, the end point of a next straight portion P(iws)is determined as iws (at Step 131).

Detailed Description Text (114):
It is then decided (at Step 132) whether or not the distance between the present position to the searched initial point P(iws) of the winding road exceeds a preset value L. If this answer of Step 132 is "YES", no winding road is present within the distance L. Therefore, the flag F is turned OFF (at Step 143), and the control routine is returned. If the answer of Step 132 is "NO", on the contrary, the searched initial point of the winding road is approaching, so that the loop variables i and j are initialized (at Step 133).

Detailed Description Text (121):
FIG. 17 shows an example of the shift control on the winding road thus searched. First of all, it is decided (at Step 151) whether or not the vehicle is running on the winding road. For this, whether or not the vehicle is located in the winding section on the map, as decided as above, may be decided by the navigation system 20. If this answer of Step 151 is "YES", this routine is returned. If the answer is "NO", on the contrary, a coming winding road is searched (at Step 152). This is executed by the aforementioned routine shown in FIG. 16.

Detailed Description Text (126):
FIG. 18 shows a control example, in which the present position is located, and coming road situations are specified (at Step 161). These operations can be executed as at Step 61 in FIG. 8. Next, it is decided (at Step 162) whether or not the 4th speed (i.e., the highest gear stage or the overdrive stage) by the downslope control is inhibited (at Step 162). In this downslope control, when a downslope is detected by the navigation system 20, the shift pattern is changed to one for the downslope so that shift is executed on the basis of the downslope shift pattern. Alternatively, a downslope is detected on the basis of the acceleration to change the shift pattern to one for the downslope so that the shift is executed on the basis of the downslope shift pattern. This downslope shift pattern has a content to inhibit the highest gear stage so that a gear stage on a lower speed side for effecting the engine brake may be set easily.

Detailed Description Text (127):
If the answer of Step 162 is "YES", it is decided (at Step 163) whether or not a flat road is in front. This decision can be made on the basis of the road data of the navigation system 20. If the answer of Step 163 is "YES", the running distance or time from the present downslope to a next downslope is calculated (at Step 164), and it is decided (at Step 165) whether or not the calculation result is less than a predetermined value stored in advance.

Detailed Description Text (135):
Here will be described an example of the upslope control. In FIG. 20 (at Step 181), the location of the present position is executed, and the situations of a road ahead of the present position are specified as at Step 161 of FIG. 18. Next, it is decided (at Step 182 whether or not the conditions for beginning the upslope control is satisfied. This condition can be exemplified by the fact that an ascending gradient higher than a predetermined reference value is detected. Incidentally, this upslope control inhibits an upshift to a gear stage on a higher speed side such as the 4th speed thereby to keep a high driving force. This shift pattern controls the shift by either a shift diagram having no gear stage region of the 4th speed or a shift diagram in which the gear stage on a lower speed side is extended to a higher speed side.

Detailed Description Text (138):
FIG. 21 shows a control example for the case in which a corner is in place of the aforementioned upslope/downslope for the road situations required for a special

control inhibiting the 4th speed. In FIG. 21, the location of the present position and the specification of the road situations ahead of the present position are executed (at Step 191) as at Step 61 of FIG. 8. If a downslope is detected in this case, the shift is executed by a shift pattern for setting a higher gear ratio easily, i.e., a shift pattern for setting a lower gear stage easily. If a corner is additionally detected, on the other hand, the shift is controlled by a shift pattern for setting a gear stage on a lower speed side more easily.

Detailed Description Text (139):
Next, it is decided (at Step 192) whether or not the 4th speed is inhibited by the downslope control. If this answer of Step 192 is "YES", it is decided (at Step 193) whether or not a corner exit is approaching. This decision can be made by the navigation system 20.

Detailed Description Text (144):
The road data can also be achieved either by the navigation system 20, as described hereinbefore, or from the actual running state, as described with reference to FIG. 14. As a result, while both the shift controls, as based upon the data achieved by the navigation system 20 and upon the actual run, are being executed, either of them is adopted according to the difference between the gear stages decided by the individual controls.

Detailed Description Text (145):
FIG. 22 shows an example of the control. The upslope/downslope control is executed on the basis of the running state such as the actual acceleration, and the shift control of the automatic transmission 2 is executed (at Step 201) on the basis of the road data achieved by the navigation system 20. The latter control is a cooperative control between the navigation system 20 and the automatic transmission 2.

Detailed Description Text (146):
It is decided at Step 202 whether or not both the controls are being executed. If this answer of Step 202 is "YES", it is decided (at Step 203) whether or not a gear stage Ssl by the upslope/downslope control is at a lower speed than the gear stage Snv, as decided by the cooperative control between the navigation system 20 and the automatic transmission 2.

Detailed Description Text (147):
If this answer of Step 203 is "YES", the shift control by the upslope/downslope control is executed. Specifically, the upslope/downslope is detected on the actual running state so that a shift, as based on a shift pattern for accordingly easily setting a gear stage on a lower speed side, is executed (at Step 204). On the contrary, if the answer of Step 203 is "NO", that is, if the gear stages by the two controls are identical or if the gear stage by the shift control by the navigation system 20 is on a lower speed side, the shift control by the cooperative control between the navigation system 20 and the automatic transmission 2 is executed (at Step 205). Incidentally, if the answer of Step 202 is "NO", the shift control being executed at that instant is executed as it is (at Step 206). Thanks to this control, the gear stage on a lower speed side is preferentially selected so that the running can be effected with an excellent power performance. As a result, the aforementioned Step 203 corresponds to comparison means in claim 10, and Steps 204 and 205 correspond to shift instructing means.

Detailed Description Text (148):
Incidentally, while both the shift control for determining the gear stage by the actual running state and the road data obtained by the running and the cooperative control of the navigation system 20 and the automatic transmission 2 are being executed, it is arbitrary to additionally select either of the shift controls simply. FIG. 23 shows this example, in which if the aforementioned answer of Step 202 of FIG. 22 is "YES", the routine instantly advances to Step 205 to execute the shift control by the cooperative control of the navigation system 20 and the automatic transmission 2. If the answer of Step 202 is "NO", on the contrary, the routine advances to Step 206, at which the shift control being executed at that instant is continued.

Detailed Description Text (149):
According to this control shown in FIG. 23, therefore, the gear stage is determined on

the basis of the road data obtained by the navigation system 20. Specifically, the gear stage is set according to the road situations ahead of the route to be followed, so that the delay in the shift control is avoided to improve the drivability.

Detailed Description Text (150):
Here will be described another example of the shift control which can be executed by the control system of the present invention. The aforementioned navigation system 20 can be stored in advance with data other than those such as the slope and curve of a road or a discrimination between an expressway or an ordinary way and can also be supplied from the outside by a communication system. The control, as shown in FIG. 24, is exemplified by the shift control which is based on such various road data.

Detailed Description Text (151):
In FIG. 24, control operations similar to those of Step 61 of FIG. 8 are executed at Step 211. On the basis of the road data by the navigation system 20, moreover, it is decided (at Step 212) whether or not the route to be followed by the vehicle contains a specific area such as the entrance/exit of an expressway, a junction of the expressway, a mountainous region, an unpaved road a farm road, a forestry road, a riverbed road or a gravel road. If the answer of Step 212 is "YES", the shift pattern is changed (at Step 213) to one for the slope/curve, which is liable to use a gear stage on a lower speed side than that of the slope shift pattern.

Detailed Description Text (155):
shift pattern. Specifically, at Step 221, control operations similar to those of Step 61 of FIG. 8 are executed, and the automatic transmission 2 is controlled by the basic shift pattern. It is then decided (at Step 222) whether or not a slope is in the route to be followed. If the answer of Step 222 is "YES", there are set the timings for changing the basic shift pattern to the slope shift pattern and vice versa on the basis of the slope situations, as detected by the navigation system 20, i.e., the gradient of the slope. Even in a series of slopes, the section, in which the slope gradient is larger than a predetermined value stored in advance in the navigation system 20, is controlled by the slope shift pattern, and the section having a smaller gradient than a predetermined value is controlled by the basic shift pattern.

Detailed Description Text (159):
Next, the present position is located by the navigation system 20, and it is decided (at Step 232) whether or not the vehicle is ascending or descending a slope with the 4th speed being inhibited. If the answer of Step 232 is "YES", it is decided (at Step 233) whether or not a change is in the gradient direction of a slope in front, such as a change from an upslope to a downslope or a change from a downslope to an upslope. If the answer of Step 233 is "YES", the slope shift pattern is retained as it is, and the control for inhibiting the 4th speed is continued (at Step 234). After this, the control routine is returned.

Detailed Description Text (162):
The control system of the present invention can perform controls in cooperation with a cruise control system for keeping a preset vehicle speed. This cruise control system sets the vehicle speed, when the switch is operated while the vehicle is running, so that the engine electronic control unit 10 controls the opening of the electronic throttle valve 7 so as to keep the vehicle speed. This control is effected by detecting the actual vehicle speed and by controlling the throttle opening to eliminate the difference from the set vehicle speed, and it may be delayed. If the running resistance is high at a corner, for example, the opening of the electronic throttle valve 7 is increased after the vehicle speed goes down, or the downshift of the automatic transmission 2 is instructed. In the case of a corner on a downslope, alternatively, the vehicle speed exceeds the preset value so that the vehicle is decelerated after the transverse acceleration (or transverse G) has considerably risen. According to the navigation system 20, on the contrary, the coming road situations can be detected so that the vehicle speed by the cruise control can be changed according to the road situations, as detected by the navigation system 20, to improve the drivability. An example is shown in FIG. 27, in which it is decided at first at Step 241 whether or not the vehicle is under a cruise control (C/C control). If this answer of Step 241 is "NO", the control is skipped out from this routine. If the vehicle is under the cruise control, on the other hand, the routine advances to Step 242, at which it is decided whether or not the travers acceleration (transverse

G) is less than a target valueother hand, the routine advances to Step 242, a when the vehicle runs at the preset speed around the coming corner.

Detailed Description Text (166):
Incidentally, here will be described a control example for preventing the busy shifting when the vehicle is running toward a corner. In FIG. 28, at first, it is decided at Step 251 whether or not the condition for inhibiting an upshift is satisfied. This is a step for deciding whether or not a condition similar to that for executing the upslope/downslope control is satisfied, and this decision is made on whether or not the condition for inhibiting the 4th speed, for example, is satisfied on the basis on the actual running state or the road data obtained from the navigation system 20. If this answer of Step 251 is "NO", the control is skipped out from this routine. If the answer is "YES", on the contrary, it is decided (at Step 252) whether or not the downshift executing condition is satisfied.

Detailed Description Text (174):
Here will be described a control example at a corner having a low coefficient (.mu.) of friction of the road surface. At first in FIG. 31, it is decided (at Step 281) whether or not the vehicle is running in a cold district. Here, this cold district is a region, in which the friction coefficient of the road surface is lowered by the snowfall, and is exemplified by a road near a specific mountain or a specific district, as stored in advance as the road data of the navigation system 20. If this answer of Step 281 is "YES", it is decided (at Step 282) whether or not it is in a specific season such as winter. At this Step 282, it is decided on the basis of the calendar data stored in the navigation system 20 whether or not it is a snowing season or a snow lying season in the aforementioned cold district.

Detailed Description Text (178):
As has been described hereinbefore, the cruise control system performs the control to keep the preset vehicle speed. If a device for detecting a vehicle ahead such as a laser radar is connected with the cruise control system, the vehicle can accompany a vehicle ahead while keeping the distance inbetween at a predetermined value. A control example for executing the so-called "inter-vehicle distance control" or "accompany control" and the shift control, as based on the road data obtained from the navigation system 20, together will be described with reference to FIG. 32.

Detailed Description Text (179):
First of all, it is decided at Step 291 whether or not the vehicle is under the cruise control (or C/C) for keeping the distance between vehicles. This decision can be made on the basis of an operation signal of the cruise control system. If this answer is "YES", the distance to a coming corner, a cornering radius R and a target cornering speed are calculated (at Step 292) on the basis of the road data which are obtained by the navigation system 20. Next, a target deceleration is calculated (at Step 293) from the vehicle speed at present and the target cornering speed (or the cornering radius R) at the corner. In this case, the target deceleration may be calculated by using the set vehicle speed in the cruise control in place of the present vehicle speed.

Detailed Description Text (185):
Next, it is decided (at Step 302) whether or not a reference point for calculating the altitude has been passed. This reference point is a point within a predetermined distance before a high-level branching point, if the level of a high-level road such as an urban motorway is to be decided, and a point at a definite level if the altitude is to be simply calculated. Here, the point having a definite level is exemplified by a very coarse altitude point in the navigation system 20 or an OFF point of the ignition switch, as located at an altitude calculated on the basis of the data set by a car dealer.

Detailed Description Text (189):
Here will be described an example of the control for discriminating the high level road such as of an urban motorway by making use of the altitude difference .DELTA.h thus determined. First of all, as shown in FIG. 34, it is decided (at Step 311) whether or not the vehicle has approached to the upslope at the entrance or the downslope at the exit of an motorway. This decision can be made on the basis of the road data of the navigation system 20. The control is skipped out from this routine, if the answer of Step 311 is "NO", but the altitude difference .DELTA.h is calculated

(at Step 312) if the answer is "YES". The routine for calculating the altitude difference .DELTA.h has already been described with reference to FIG. 33.

Detailed Description Text (191):
According to this control shown in FIG. 34, not only the road data by the navigation system 20 but also the road data as a result of the actual run can be achieved so that the shift control of the automatic transmission 2, as based on the road data, can be more accurately executed. In other words, the upslope/downslope at the entrance/exit of the high level road can be executed without any delay to improve the acceleration at the time of entering into the motorway or high-level road and the deceleration at the time of leaving the motorway.

Detailed Description Text (192):
FIG. 35 shows a control routine for calculating the altitude of the present position. In FIG. 35, at first, it is decided (at Step 321) whether or not a reception is made from the GPS (Global Positioning System). If this answer of Step 321 is "NO", the control is skipped out from this routine. If the answer of Step 321 is "YES", on the contrary, the altitude is calculated (at Step 322). Specifically, the altitude is calculated by adding the altitude difference .DELTA.h, as calculated in the aforementioned control of FIG. 33, to the altitude h of the reference point. Next, the present position is calculated (at Step 323) from the data of GPS and the altitude data, as calculated at Step 322.

Detailed Description Text (193):
According to the control of FIG. 35, therefore, the information content for calculating the present position increases to improve the calculation accuracy of the present position. By the altitude data thus obtained, moreover, the error of the present position by the navigation system 20 can also be corrected. In this case, the error correction may be made by detecting the point, in which the altitude or slope highly changes, and by comparing the detected point with the present position. Especially in the case of a map matching, the changing point can be detected even on a straight road so that the map matching can be easy and accurate. According to the control of FIG. 35, moreover, even if the receiving state from the GPS is poor or even if the number of receiving satellites is small, the present position is calculated from the data, as based on the actual run result, so that the reliability of the shift control, as based on the navigation system 20 and the road data, is improved better.

Detailed Description Text (194):
Here will be described an example in which the road data obtained by the navigation system 20 are used for controlling the oil temperature of the automatic transmission 2. FIG. 36 shows one example, in which it is decided (at Step 331) on the basis of the road data of the navigation system 20 whether or not an upslope is continued in front longer than a predetermined distance. If this answer of Step 331 is "NO", the control is skipped out from this routine. If the answer is "YES", on the contrary, it is decided (at Step 332) whether or not the oil temperature Tat of the automatic transmission 2 is higher than a predetermined value and has a tendency to rise (.DELTA.Tat>0). The control is skipped out from this routine, if the answer of Step 332 is "NO", but the suppressive control of the oil temperature of the automatic transmission 2 is executed (at Step 333) if the answer is "YES".

Detailed Description Text (195):
This oil temperature suppressing control of Step 333 is specifically exemplified by the control for lowering the engine RPM by changing the shift point to a lower speed side to make it liable to use a lower gear ratio, the control for increasing the circulating oil flow by raising the line pressure of the automatic transmission 2 to raise the charge oil pressure to the torque converter, or the control for reducing the deviation of an oil temperature distribution to damp the influences by a high oil temperature by raising the lubricating oil pressure to increase the lubricating oil flow. Independently of or together with these controls, on the other hand, there may be executed a control for lowering the engine RPM and reducing the input torque to the automatic transmission 2 by reducing the opening of the electronic throttle valve 7. This control of the opening of the electronic throttle valve 7 is effective for the case in which the oil temperature is so further raised that a thermal influence upon the resin members is worried.

Detailed Description Text (214):
Here will be exemplified another mode of embodiment or additional construction, as including the individual features of the present invention. The control system, as including the first and second featuring constructions of the present invention, can include means for changing a shift pattern for the upslope/downslope to a shift pattern for a curve, as liable to set a lower gear stage than the former. These control systems can further include means for setting the shift pattern for the curve when it is decided that the driving tendency is sporty. The control system, as including the first and second featuring constructions, can be constructed to detect an intersection as a curved road when the route to be followed is turned at the intersection. The control system, as including the first and second featuring constructions, can execute the change of the shift pattern not only by the means for effecting the change by changing the shift diagram but also by moving the shift point substantially by adding/subtracting a correction value to and from the detected data such as the vehicle speed or the throttle opening.

Detailed Description Text (216):
The shift pattern control means of the control system including the third featuring construction of the present invention can further include the means for changing the shift pattern to a shift pattern for entrance after the downshift has been executed. The control system including this third featuring construction can be constructed to change the shift pattern into the shift pattern for entrance when the driving tendency is sporty. The control system including this third featuring construction can be constructed such that the shift pattern control means changes the shift pattern when the start from the facilities belonging to an expressway is detected by the road data detecting means. The control system including the third featuring construction can further include the means for returning the shift pattern for entrance to the shift pattern before changed to the entrance shift pattern when joining to a main line of the expressway is detected. The control system including the third featuring construction can further include the means for returning the entrance shift pattern to the shift pattern before changed to the entrance one, when a cruising speed run having little change in the vehicle speed is detected.

Detailed Description Text (217):
The shift pattern control means of the control system including the fourth featuring construction of the present invention can be the means for changing the shift pattern inhibiting the setting of the lowest gear stage to the shift pattern for a low-.mu. road. The shift pattern control means of the control system including the fourth featuring construction can be the means adopting the shift pattern, in which the downshift point is set at a lower speed side, as the shift pattern for the low-.mu. road. The control system including the fourth featuring construction can include the means for keeping the low-.mu. road shift pattern even when the main switch or the ignition switch of the vehicle is turned OFF. The road data detecting means in the control system including the fourth featuring construction can include the means for deciding it on the basis of the cold area data, as stored in advance, the ambient temperature or the calendar data that the coefficient of road surface friction is small. The control system including the fourth featuring construction can further include the means for changing the slip region, in which the lockup clutch is controlled to slip at the time of a deceleration, to a higher speed side when the shift pattern is changed to the low, road shift pattern.

Detailed Description Text (218):
In addition to the means for changing the shift pattern by changing the shift diagram, the control system including the fifth featuring construction of the present invention can move the shift substantially by adding/subtracting a correction value to and from the detected data such as the vehicle speed or the throttle opening.

Detailed Description Text (219):
The control system including the sixth featuring construction of the present invention can be constructed such that the downslope decision changing means changes the reference value for deciding the downslope when the driving tendency is sporty. The shift pattern control means of the control system including the sixth featuring construction can include the means for changing the shift pattern for the downslope to the shift pattern for the corner/downslope, as liable to use a larger gear ratio. The downslope decision changing means in the control system including the sixth featuring

construction can include the means for changing the reference value for deciding the downslope while considering the radius of the corner.

Detailed Description Text (222):
The shift pattern control means of the control system including the ninth featuring construction of the present invention can include the means for changing the shift pattern for inhibiting the highest gear stage such as the 4th speed to the shift pattern for the upslope/downslope. The upslope/downslope control decision means in the control system including the ninth featuring construction can include the means for executing the shift instruction with the upslope/downslope shift pattern when it is decided that the driving tendency is sporty. The upslope/downslope control decision means in the control system including the ninth featuring construction can include the means for continuing the control inhibiting the highest gear stage such as the 4th speed.

Detailed Description Text (224):
The driving tendency deciding means in the control system including the eleventh featuring construction of the present invention can include the means for deciding the driving tendency on the basis of the accelerating operation or the braking operation during the cornering or just before the entrance into the corner. The shift correcting means in the control system including the eleventh featuring construction can include the means for changing the shift point on the basis of the detected driving tendency. The shift correcting means in the control system including the eleventh featuring construction can include the means for changing the application oil pressure and/or the throttle opening at a transient shift time, on the basis of the detected driving tendency.

Detailed Description Text (234):
According to the control system including the ninth featuring construction of the present invention, when the vehicle runs on an upslope or downslope, the transmission can be controlled on the basis of the shift pattern which is liable to set a higher gear ratio. Moreover, when the flat road existing in an intermediate portion between the upslope/downslope is short or when the time required for passing the flat road is short, the shift control, as based on the shift pattern for the upslope/downslope, is not interrupted but continued. If the distance or time is long, on the contrary, the shift control by the shift pattern for the upslope/downslope is once interrupted during the run on the flat road. Moreover, if an upslope/downslope is detected between flat roads and if its distance or time required for passing it is short, the shift control by the shift pattern for the upslope/downslope is not executed. If the same is long, on the contrary, the shift control, as based on the upslope/downslope shift pattern, is executed. Therefore, if the shift pattern is changed and if the running distance or time of the changed shift pattern is decided to be short, the shift pattern is not changed. As a result, the frequency of the shifts, as accompanying the change in the shift pattern, is lowered to improve the drivability.

Other Reference Publication (2):
A. Bastian, et al., Proceedings of the International Conference on Fuzzy Systems, International Joint Conference of the 4.sup.th International IEEE Conference on Fuzzy Systems and the 2.sup.nd International Fuzzy Engineering Symposium, vol. 2, pp. 1063-1070, Mar. 20, 1995, "System Overview and Special Features of Fate: Fuzzy Logic Automatic Transmission Expert System".

Other Reference Publication (3):
Andreas Bastian, Vehicle System Dynamics, vol. 24, No. 4/05, pp. 389-400, Jun. 1, 1995, "Fuzzy Logic in Automatic Transmission Control".

CLAIMS:

5. A control system for a transmission, comprising:

shift control means for outputting a shift instruction signal on the basis of a predetermined shift pattern;

road data detecting means for detecting the road data of a route to be followed by a vehicle;

shift pattern control means for setting a shift pattern for entering to a freeway, as having a control content for making it ready to set a larger gear ratio, as said shift pattern when it is detected by said road data detecting means that an actual position of the vehicle on the route to be followed by said vehicle is an entrance of the freeway.

11. A control system for a transmission, comprising:

shift control means for outputting a shift instruction on the basis of a predetermined shift pattern;

road data detecting means for detecting the road data of a route to be followed by a vehicle;

brake detecting means for detecting the execution of a wheel braking operation in said vehicle;

shift inhibiting means for inhibiting the shift in said transmission when it is detected by said brake detecting means that the route to be followed by said vehicle is a curved road and when the wheel braking operation is detected by said brake detecting means; and

shift inhibition releasing means for allowing the shift in said transmission when the end of the curved road is detected by said road data detecting means.

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L13: Entry 3 of 6 File: USPT Dec 28, 1999

DOCUMENT-IDENTIFIER: US 6009374 A
TITLE: Apparatus for and method of controlling vehicular systems while travelling

Abstract Text (1):
A vehicle-mounted travel control system including a navigation system control section which controls a storage section, a position detection section for detecting the present position of the vehicle, a course decision section for deciding an intended travel course of the vehicle. The travel control system also includes a central control section for managing control sections based on information of various sensors installed in the vehicle. The system also includes a terminal device which is connected to the navigation system control section and the central control section. The terminal device is adapted to determine at least one predetermined time responsive to an actual vehicle speed based on actual vehicle speed information transferred from said central control section, and the navigation system control section is adapted to determine an intended travel position after elapse of a predetermined time with reference to the present position of the vehicle based on the vehicle speed and predetermined time transferred from the terminal device.

Brief Summary Text (2):
The present invention relates to a vehicle-mounted travel control system, and more particularly, to a vehicle-mounted travel control system which is applicable to controlling a vehicle by the use of a navigation system, and especially, which can predictively provide optimal control of the vehicle responsive to determination of an intended future travel position.

Brief Summary Text (4):
In the field of vehicle mounted travel control systems, many type of navigation systems have been proposed in the past. FIG. 13 is a block diagram showing a conventional vehicle mounted travel controlling system.

Brief Summary Text (5):
Referring to FIG. 13, a central control section 101 synthetically processes information from control sections such as an engine control section 102 for controlling an engine of a vehicle and a transmission control section 103 for controlling a transmission. In this context, "synthetically" means that the control is comprehensive, that is, that the central control section 101 controls virtually all control sections. Also, a navigation system control section 104 controls navigation of the vehicle and a storage section 105 stores map information. A course decision section 106 processes information about a destination of the vehicle and a designated course to determine the future course of the vehicle, a position detection section 107 measures the present position of the vehicle using signals from a sensor or an artificial satellite, a display section 108 displays the map information, the present position of the vehicle and the future course of the vehicle, and a voice message notification section 109 provides voice messages. Generally, an automobile includes, as shown in FIG. 13, the engine control section 102 for processing information from various sensors and the transmission control section 103, and controls the engine, transmission, suspension, steering system, air conditioning system and lighting device, etc., under the control of the control sections.

Brief Summary Text (6):
The conventional navigation system can designate a starting point, a destination of the vehicle and a designated course based on the results of processing by the course

decision section 106 and the position detection section 107. A scheduled course of the vehicle is calculated by the course decision section 106 in combination of the map information previously stored in the storage section, and as a consequence, the present position of the vehicle and a direction of travel at an intersection and the like are displayed on the display section 108 or provided by voice with the voice message notification section 109, whereby the vehicle can be guided.

Brief Summary Text (7):
In the above prior art, a navigation system is described which guides the vehicle by displaying or providing an audible indication of the present position of the vehicle and the direction of travel at an intersection and the like. However, other conventional navigation systems include those which can calculate a distance and a required time between the present position of the vehicle and an intersection and the like where the direction is changed, and can inform the driver of the change by voice or by a visual display. Prior art systems also include those which can obtain weather information and information about vacant parking lots from radio transmissions sent by a radio station and the like, and can provide this information to the driver, again either visually with a display or audibly with a voice-based system.

Brief Summary Text (10):
Further, an apparatus for controlling the shifting of an automatic transmission based upon the number of revolutions of the engine and vehicle speed, an apparatus for controlling a vehicle suspension from a rotation angle of the steering wheel and a vehicle speed, an apparatus for controlling a gear change-up timing or gear change-down timing with the back-and-forth inclination of a traveling vehicle, an apparatus for controlling a lighting device in accordance with surrounding brightness, and an apparatus for controlling a vehicle height in accordance with a vehicle speed are all known.

Brief Summary Text (11):
A system in which a vehicle is controlled on the basis of information from a navigation system is also known. For example, a vehicle air conditioning apparatus is disclosed in Japanese Unexamined Patent Publication No. 4-201712, and a hybrid-type vehicle is disclosed in Japanese Unexamined Patent Publication No. 6-187595.

Brief Summary Text (12):
The former vehicle air conditioning apparatus controls an air conditioning device of the vehicle by the map information of the navigation system and travel information in such a manner that an air conditioner is automatically switched from external air inlet to internal air circulation when going into a tunnel, and controls an air conditioning device of the vehicle in a traffic jam by judging the traffic jam environment with a distance traveled per hour. The latter hybrid-type vehicle increases accuracy of information for guiding the vehicle by adding information about the road on which the vehicle is traveling to the map information of the navigation system, and switches a drive force (specifically, an engine and a motor) responsive to the travel position by adapting the vehicle to the condition of different environment even at the same point, such as a multilevel intersection.

Brief Summary Text (13):
Since the conventional central control section and navigation system of the vehicle are separately and individually constructed as described above without combination, they cannot control the vehicle by mutually using the information from the sensors and the navigation system mounted on the vehicle.

Brief Summary Text (14):
In addition, although they can judge the position of the road along which the vehicle passes immediately after a present position (imaginary course), they have no means for knowing the condition of the imaginary course. Therefore, since various control operations are performed after obtaining the present information from the sensors and navigation system mounted on the vehicle, the control of the vehicle may be delayed, or the vehicle may be erroneously controlled.

Brief Summary Text (15):
Further, conventional navigation systems can virtually move the vehicle on a map when calculating the scheduled course. However, this is performed by using predetermined

data such as a vehicle speed, and conventional navigation systems can not use the actual vehicle speed of the traveling vehicle, and further, can not predict the intended travel position after the passage of a predetermined time with reference to the present position.

Brief Summary Text (17):
The present invention has been made to overcome the problems of the conventional navigation systems described above.

Brief Summary Text (18):
An object of the invention is to provide a vehicle-mounted travel control system which can predict an intended travel position after a predetermined time with reference to the present position of the vehicle.

Brief Summary Text (19):
Another object of the invention is to provide a vehicle-mounted travel control system which can predictively control the vehicle in advance using information obtained from the navigation system before arriving at the intended travel position.

Brief Summary Text (20):
According to general aspect of the invention, a vehicle-mounted travel controlling system comprises a navigation system control section which controls a storage section, a position detection section for detecting the present position of the vehicle, a course decision section for deciding an intended travel course of the vehicle; a central control section for synthetically managing each of the control sections based on information from various control sections installed in the vehicle; and a terminal device which is connected to the navigation system control section and the central control section, and which processes information of both the navigation system control section and the central control section to transfer the information to said the navigation system control section and the central control section.

Brief Summary Text (22):
The navigation system control section is adapted to determine an intended travel position after the passage of a predetermined time with reference to the present position of the vehicle based on the vehicle speed and predetermined time transferred from the terminal device, and is adapted to advance the virtual position of the vehicle as stored in a memory to the determined intended travel position.

Drawing Description Text (4):
FIG. 3 illustrates an example of contents of map information and position information.

Drawing Description Text (5):
FIG. 4 illustrates a method of arranging the present position p1 on an image memory to determine coordinates.

Drawing Description Text (6):
FIG. 5 illustrates a method for traveling a vehicle on an image memory from the present position p1 to the intended travel position p2 along a midway course.

Drawing Description Text (7):
FIG. 6 illustrates a method for converting coordinates of the intended travel position p2 in the image memory into the actual longitude and latitude.

Drawing Description Text (8):
FIG. 7 illustrates a method for detecting a curvature condition between the present position p1 and the intended travel position p2.

Drawing Description Text (14):
FIG. 13 is a block diagram showing a relationship between a central control section and a navigation control section of a conventional vehicle.

Detailed Description Text (3):
FIG. 1 is a block diagram showing a configuration of a vehicle-mounted travel control system according to a first embodiment of the present invention. Referring to FIG. 1,

a central control section 1 synthetically processes information pertaining to control sections of a vehicle such as an engine control section 2 for controlling an engine of the vehicle and a transmission control section 3 for controlling a transmission of the vehicle, and others. The engine control section 2 and transmission control section 3 are typical examples of the control sections of the vehicle. A navigation system control section 4 controls navigation of the vehicle; a storage section 5 stores map information; a course decision section 6 processes information about a destination of the vehicle and a designated course of the vehicle to decide a future course of the vehicle; a position detection section 7 measures the present position of the vehicle with information from artificial satellites and sensors; a display section 8 displays map information, the present position of the vehicle, and the future course of the vehicle to provide information concerning these to the driver; a voice message notification section 9 generates a voice message to provide such information to the driver, and a terminal device 10 connects the central control section 1 and the navigation system control section 4 of the vehicle, and calculates data pertaining to both sections to transfer the data suitably to the central control section 1 and the navigation control section 4.

Detailed Description Text (5):
As described above, the terminal device 10 collects and calculates information from the central control section 1 and the navigation system control section 4 of the vehicle, and suitably transfers the results of its calculations to the central control section 1 and the navigation system control section 4 (step S1). At this time, the central control section 1 exchanges information with the terminal device 10 while synthetically managing control sections such as the engine control section 2 and the transmission control section 3 (step S2), and the navigation system control section 4 also exchanges information with the terminal device 10 (step S3). The navigation system control section 4 orders measurement of the present position of the vehicle, adjustment of the measured information of the present position of the vehicle and the map information, and decision of the optimum intended course, to each of the sections.

Detailed Description Text (6):
First, the terminal device 10 requests the navigation system control section 4 to provide position information of the present position p1 of the vehicle (step S4). The navigation system control section 4, when asked for the position information of the present position p1 of the vehicle from the terminal device 10, transfers the position information of the present position p1 of the vehicle, which is previously obtained by calculation on the basis of the map information stored in the storage section 5 and the information about the present position of the vehicle detected by the position detection section 7, to the terminal device 10 (step S5). The position information of the present position p1 of the vehicle is obtained by superimposing the position information detected by the position detection section 7 onto the map information read from the storage section 5. The position information is stored in the storage section 5 after calculation thereof, and read from the storage section 5 to be transferred to the terminal device 10. The position information of the vehicle detected by the position detection section 7 is obtained from the artificial satellites and sensors. In the storage section 5, information about latitude, longitude, altitude and other attributes are stored as the position information together with the map information, as shown in FIG. 3. For example, the information about latitude, longitude, altitude and attribute are interrelated in such a manner that the storage section can indicate that the vehicle is situated at 139.degree.45' east longitude, 35.degree.40' north latitude, altitude of 10 m, and the attribute may be the information that the ground the vehicle is travelling over is an ordinary road. The attribute thus may include information about conditions of the road, such as an ordinary road, an ordinary road and a railroad crossing, a highway, or a highway and a tunnel.

Detailed Description Text (7):
Next, the terminal device 10, when it obtains the position information of the present position p1 of the vehicle from the navigation system control section 4 (step S6), requests the central control section 1 to provide the present vehicle speed information of the vehicle (step S7). The central control section 1, when requested to provide the vehicle speed information from the terminal device 10, transfers the present vehicle speed information detected by a vehicle speed sensor to the terminal device 10 (step S8). The terminal device 10, when it obtains the present vehicle speed

information v1 from the central control section 1 (step S9), determines a suitable predetermined time t1, which is responsive to the obtained vehicle speed information v1, and transfers the obtained vehicle speed information v1 and the predetermined time t1 to the navigation system control section 4 (step S10).

Detailed Description Text (8):
The navigation system control section 4, when the vehicle speed information v1 and the predetermined time t1 from the terminal device 10 have been transferred to it, determines an intended travel position p2 after the lapse of the predetermined time t1 with the vehicle speed v1 and the predetermined time t1 based on the present position p1 read from the storage section 5, using an imaginary course processed by the course decision section 6 based on the information about the predesignated destination and course, and virtually advances the virtual position of the vehicle in memory to the determined intended travel position p2 (step S11).

Detailed Description Text (9):
This can be performed in such a manner as shown in FIG. 4. First, the map information storing therein the present position p1 of the vehicle, which is previously obtained by calculation, is read out from the storage section 5 and written in an image memory. Next, the imaginary course k processed by the course decision section 6 is superimposed onto the image memory. Then, after reading the present position p1, coordinates (Xp1, Yp1) of the present position p1 on the image memory is read. Then, as shown in FIG. 5, the coordinates are moved along the imaginary course k processed by the course decision section 6. The method of moving the coordinates along the imaginary course may include a method in which the correspondence between the coordinates which numerically express the imaginary course and the coordinates to be moved is checked, and a method in which a line showing a road of the map information is identified, and the coordinates are moved along the line.

Detailed Description Text (10):
An amount of movement at this time is determined by the scale of the map information, the vehicle speed v1 and the time t1. If the coordinates on the image memory are moved by 1 dot under the map information of the scale corresponding to 100 M such that the vehicle speed v1 is taken as 36 km/h, and the time t1 is taken as 60 seconds, the coordinates are moved by 600 m=6 dots. Coordinates p2 (Xp2, Yp2) after movement become the intended travel position, and the position of the vehicle can be virtually advanced.

Detailed Description Text (11):
As described above, according to this embodiment, the position of the vehicle is advanced in memory from the present position p1 to the intended travel position p2 along an imaginary course based on the actual vehicle speed and the predetermined time corresponding thereto. Thus, as described later in detail, the position information corresponding to the intended travel position p2 can be obtained from the storage section 5. For this reason, the vehicle can be optimally controlled in advance in response to the position information of the advanced intended travel position p2 before actually arriving at the intended travel position p2. For example, when the attribute of the road at the intended travel position p2 is an ordinary road, highway and the like, the vehicle can be predictively controlled in response thereto. The position information shown in FIG. 3 shows an example, and the position information is not limited thereto.

Detailed Description Text (12):
When the vehicle is decelerating to a stop to wait for a traffic light and the like, the vehicle speed v1 becomes "0" according to the above-described method alone, so that the intended travel position cannot be calculated. In this case, the terminal device 10, when it judges that the present vehicle speed is zero and the vehicle is stopping from the actual vehicle speed transferred from the central control section 1, may set a provisional vehicle speed v2 (for example, 30 km/h) in place of the actual vehicle speed v1, and determine the predetermined time responsive to the set provisional vehicle speed. As a result, since the intended travel position after the lapse of the predetermined time can be calculated even if the vehicle is stopping, the position of the vehicle can be advanced in memory to the intended travel position after the lapse of the predetermined time.

Detailed Description Text (13):
Then, a linear expression representing a straight line which connects the present position p1 to the intended travel position p2 of the vehicle will be formulated. Since the information about the longitude and latitude of the present position p1 of the vehicle is already known by being stored in the storage section 5 as the position information, the longitude and latitude of the intended travel position p2 can be calculated using the longitude, latitude and the above linear expression.

Detailed Description Text (14):
This may be also performed, for example, by the method shown in FIG. 6. When the map information is written in the image memory, it is adjusted to the maximum value and the minimum value of the longitude and latitude. The range determined thereby is divided by predetermined lines (grid), and the values of the grid crossing the intended travel position p2 are read, whereby the longitude and latitude of the intended travel position p2 can be obtained.

Detailed Description Text (15):
Then, the position information (altitude, attribute) of the intended travel position p2 corresponding to the longitude and latitude of the resulting intended travel position p2 is read out from the storage section 5 and transferred to the terminal device 10 (step S12). As shown in FIG. 3, when the longitude and latitude are determined, the altitude and attribute corresponding thereto can be obtained. As a result, the terminal device 10 can obtain the present position information and the position information after the lapse of the predetermined time t1 of the vehicle (step S13).

Detailed Description Text (16):
As described above, according to this embodiment, the position information of the vehicle, such as the altitude and attribute, corresponding to the longitude and latitude of the intended travel position can be known. Thus, the vehicle can be optimally controlled in advance in response to the position information of the intended travel position, such as the altitude and attribute, before actually going to the intended travel position. For example, since the vehicle can expect to encounter an uphill road or a downhill road based on the information about the altitude at the intended travel position, the vehicle can be predictively controlled in response thereto. In addition, when the attribute of the road at the intended travel position p2 is ordinary road, highway and the like, the vehicle can be controlled in response thereto to be in an optimal setting for such conditions prior to actually encountering them.

Detailed Description Text (17):
Next, when the position information of the intended travel position p2 is transferred from the navigation system control section 4 to the terminal device 10, coordinates a (FIG. 5) in the middle of the path from the coordinates of the present position p1 to the coordinates of the intended travel position p2 in the image memory are simultaneously transferred to the terminal device 10. Although three intermediate or midway coordinates a are illustrated in FIG. 5 for convenience, the number of the midway coordinates is not limited thereto.

Detailed Description Text (18):
The terminal device 10, as shown in FIG. 7, uses the midway coordinates (Xpi-1, Ypi-1)(Xpi, Ypi)(Xpi+1, Ypi+1) in the middle of moving the dot from the coordinates (Xp1, Yp1) of the present position p1 to the coordinates (Xp2, Yp2) of the intended travel position along the imaginary course so as to calculate a distance of the course and information about a curve. The former distance can be obtained by calculating the coordinate information and the scale of the map.

Detailed Description Text (19):
The latter curve is decided by, for example, as shown in FIG. 7, connecting the present position p1 and the intended travel position p2 with a straight line, and by checking whether or not the coordinates (Xpi, Ypi) are on the connected line. If the coordinates (Xpi-1, Ypi-1) immediately before the curve are on the line, and the coordinates (Xpi, Ypi) are to the right of the line, the terminal device judges that a curve exists between the coordinates (Xpi-1, Ypi-1) and the coordinates (Xpi, Ypi). In addition, if the position of the coordinates (Xpi, Ypi) greatly deviates rightward

from the connected line, the terminal device judges the existence of a sharp left curve.

Detailed Description Text (21):
In the above-described embodiment, the position detection section 7 reads out the altitude of the present position p1 from the map information of the storage section 5. However, the position detection section 7 may measure the latitude, longitude and altitude by itself by receiving signals from artificial satellites. In this case, the measurement can be performed without using the map information of the storage section 5.

Detailed Description Text (22):
In the above embodiment, a case is described where the number of the intended travel positions p2 after the lapse of the predetermined time is one. However, the present invention is not limited thereto, and the number of predetermined times may be more than one so as to increase the amount of course information. Here, the terminal device 10 determines a plurality of predetermined times responsive to the vehicle speed based on the vehicle speed information transferred from the central control section 1, and transfers them to the navigation system control section 4. The navigation system control section 4 determines a plurality of intended travel positions based on the plurality of predetermined times and the vehicle speed information to advance the position of the vehicle in memory. In this case, the vehicle can be controlled more accurately than a case where the number of the intended travel positions after elapse of the predetermined time is one.

Detailed Description Text (34):
The third embodiment will be described with reference to the vehicle-mounted travel controlling system shown in FIG. 8. The terminal device 10 compares information about the altitude from the present position information obtained in the first embodiment and the intended travel position information after the lapse of the predetermined time so as to obtain the difference in altitude between the two points, obtains the distance from the present position to the intended travel position, and calculates an average grade of the intended travel course from the obtained altitude and distance.

Detailed Description Text (37):
In addition, when the traveling vehicle is sequentially upshifting the gear, the central control section 1 instructs the transmission control section 3 based on the gear-controlling information transferred from the terminal device 10 to control a gear change-up timing of the transmission immediately before going into the grade of the intended travel course. For example, it is possible to control the transmission control section 3 by switching the gear change-up timing to that for an uphill road. In addition, for some values of the information for controlling the gear, it is possible not to upshift the gear even if the vehicle speed or the number of revolution of the engine reaches the predetermined value. When the grade of the intended travel course is an up grade, it is possible, for example, to travel the vehicle without changing up the gear but instead maintaining second gear.

Detailed Description Text (38):
On the other hand, the terminal device 10, when it judges the grade of the intended travel course to be more of a down grade than the predetermined one and judges the present gear unsuitable, produces gear-controlling information responsive to the grade state, and transfers it to the central control section 1. For example, if the grade of the intended travel course is a gentle down grade, the central control section 1 instructs an earlier gear change-up timing than the normal one, and instructs the transmission control section 3 to upshift the gear, and further instructs the engine control section 2 to reduce the number of revolutions.

Detailed Description Text (40):
As described above, according to this embodiment, the difference in altitude is obtained from the altitude of the present position and the altitude of the intended travel position of the vehicle, the distance between the present position and the intended travel position is obtained, the average grade of the intended travel course is obtained based on the obtained altitude and distance, and the grade condition of the intended travel course is judged based on the obtained average grade. Thus, it can be learned whether the grade of the intended travel course is an up grade or a down

grade, thereby controlling the vehicle in accordance with the grade condition.

Detailed Description Text (41):
According to this embodiment, when it is judged that the traveling in the present state of the transmission is unsuitable based on the judged grade condition of the intended travel course and the actual value of the gear, transmission gear-controlling information is produced based on the grade condition of the intended travel course and the actual value of the gear, and the value of the gear and the gear change-up timing are controlled by the transmission control section 3 based on the produced gear-controlling information before moving into the grade of the intended travel course. Thus, it is possible to set the optimum value of the gear responsive to the grade of the intended travel course. For this reason, since the optimum driving force responsive to the grade can be obtained, a shortfall in driving force can be prevented at the time of the up grade, and safety can be increased by suitably applying engine braking at the time of the down grade.

Detailed Description Text (43):
In the above third embodiment, a predictive control assuming an automatic transmission is described. However, the present invention is not limited thereto. For example, in case of a vehicle having a manual transmission, the terminal device 10, when it judges the present gear unsuitable, may read out the voice message of the alarm information from the message storage section 11 and transfer it to the voice message notification section 9, and the voice message notification section 9 may produce the voice message transferred from the terminal device 10 to the driver immediately before going into a grade along the intended travel course. The alarm information includes information such that the present gear is unsuitable, and information for notifying more suitable gear than the present gear. By this, since unsuitability of the present gear and the optimum gear can be learned by the voice message immediately before going into a grade along the intended travel course, the gear can be changed to the optimum one immediately before going into the grade of the intended travel course, and then the vehicle can go into the grade.

Detailed Description Text (46):
This embodiment will be described with reference to the vehicle-mounted travel controlling system shown in FIG. 8. The terminal device 10 calculates a fuel mixing ratio at the present position based on the altitude information of the present position transferred from the navigation system control section 4, and judges whether or not it is necessary to change the present fuel mixing ratio calculated based the grade condition of the intended travel course which is judged as in the manner of the third embodiment. The terminal device 10, when it judges it necessary to change the present fuel mixing ratio, produces fuel mixing ratio-controlling information based on the present fuel mixing ratio and the grade state of the intended travel course. The central control section 1 instructs the engine control section 2 based on the fuel mixing ratio-controlling information transferred from the terminal device 10 to control the fuel mixing ratio before going into the grade of the intended travel course.

Detailed Description Text (50):
The terminal device 10 judges whether a tunnel exists on the intended travel route based on the attribute of the position information of the intended travel position after the lapse of the predetermined time. When it judges the existence of the tunnel on the intended travel position, the terminal device 10 produces light turn-on controlling information such that, for example, the headlights are turned on immediately before going into the tunnel. The time required for moving from the present position to the intended travel position is determined by the present vehicle speed and the distance between the present position and the intended travel position. The time immediately before going into the tunnel is set based on the determined moving time. The central control section 1 instructs the lighting control device 15 based on the light turn-on controlling information transferred from the terminal device 10 to turn on the light immediately before going into the tunnel on the intended travel position.

Detailed Description Text (51):
As described above, according to this embodiment, when it is judged that the tunnel exists at the intended travel position, light turn-on controlling information such

that the light is turned on immediately before going into the tunnel is produced, and the light is turned on by the lighting control device 15 based on the produced light turn-on controlling information immediately before going into the tunnel on the intended travel position. Thus, the light can be automatically turned on immediately before going into the tunnel on the intended travel position. For this reason, each manual turn-on of the light when the tunnel is in sight can be eliminated, and the light can be securely turned on without being delayed for moving into the tunnel.

Detailed Description Text (52):
As described in the first embodiment, the terminal device 10 can obtain several pieces of information about the intended travel position at several predetermined times. For example, if a time longer than the predetermined time t1 is given to the navigation system control section 4, ahead course information can be obtained. In this way, the terminal device 10, when it judges that more than one tunnel exists on the intended travel course, produces light ON/OFF-controlling information such that the light is turned on immediately before going into the first tunnel on the intended travel course and the light is turned off immediately after passing through the last tunnel. The central control section 1 instructs the lighting control section 15 based on the light ON/OFF-controlling information transferred from the terminal device 10 to turn on the light immediately before going into the first tunnel on the intended travel course, and to turn off the light immediately after passing through the last tunnel. For example, when the vehicle passes through the second tunnel immediately after passing through the first tunnel, the vehicle speed v1 immediately before passing through the first tunnel and the distance of the second tunnel are calculated. When the OFF/ON timer of the light is within the predetermined time, the light is kept on until the vehicle passes through the second tunnel.

Detailed Description Text (53):
As described above, according to this embodiment, when it is judged that several tunnels exist at several intended travel positions, light ON/OFF-controlling information is produced such that the light is turned on immediately before going into the first tunnel, and turned off immediately after passing through the last tunnel by the lighting control section 15 based on the produced light ON/OFF-controlling information. Thus, the light can be automatically turned on immediately before going into the first tunnel and turned off immediately after passing through the last tunnel. For this reason, frequent turning ON and OFF of the light can be prevented, thereby increasing the life of the light.

Detailed Description Text (54):
Similarly, the terminal device 10 judges whether a tunnel exists on the intended travel course based on the attribute of the position information of the intended travel position after the lapse of the predetermined time. When it judges that the tunnel exists on the intended travel course, the terminal device 10 produces air inlet path-controlling information such that an air conditioner is switched from external air inlet to internal air circulation immediately before going into the tunnel. The central control section 1 instructs based on the information for controlling air inlet path transferred from the terminal device 10 to switch the air conditioner from an external air inlet to internal air circulation.

Detailed Description Text (55):
As described above, according to this embodiment, when it is judged that a tunnel exists on the intended travel position, air inlet path-controlling information is produced such that the air conditioner is switched from obtaining air from an external air inlet to internal air circulation immediately before going into the tunnel, and the air conditioner is switched from external air inlet to internal air circulation immediately before going into the tunnel by the air inlet path control section 16 based on the produced air inlet path-controlling information. Thus, contaminated air in the tunnel can be prevented from entering the vehicle when the vehicle goes into the tunnel. In addition, in the case of successively existing tunnels, it is also possible to avoid frequent switching of the air inlet path of the air conditioner.

Detailed Description Text (57):
Similarly, the terminal device 10 judges whether a tunnel exists on the intended travel course based on the attribute of the position information of the intended travel position after the lapse of the predetermined time. When it judges that a

tunnel exists on the intended travel course, the terminal device 10 produces suspension-controlling information such that the suspension is controlled immediately before and immediately after the tunnel so as to prepare for side winds generated immediately before and immediately after the tunnel. The central control section 1 instructs the suspension control section 12 based on the suspension-controlling information transferred from the terminal device 10 to control the suspension in preparation for the side winds generated at immediately before and immediately after the tunnel.

Detailed Description Text (58):
As described above, according to this embodiment, when it is judged that a tunnel exists on the intended travel position, suspension-controlling information is produced such that the suspension is controlled so as to prepare for the side winds generated immediately before and immediately after the tunnel, and the suspension is controlled by the suspension control section 12 based on the produced information for controlling the suspension. Thus, the suspension can be controlled, for example, to be rather stiff. For this reason, stable travelling can be obtained even if side winds blow immediately before and immediately after the tunnel. A case is herein described where the suspension is controlled immediately before and immediately after the tunnel. However, the present invention is not limited thereto, and the suspension may be controlled at least either immediately before or immediately after the tunnel.

Detailed Description Text (59):
Similarly, the terminal device 10 judges whether a tunnel exists on the intended travel course based on the position information of the intended travel position after the lapse of the predetermined time. When it judges that a tunnel exists at the intended travel position, the terminal device 10 produces drive source-controlling information such that the drive source of the hybrid-type vehicle is controlled immediately before going into the tunnel. The central control section 1 instructs the drive source control section 2a based on the drive source-controlling information transferred from the terminal device 10 to switch the drive source of the hybrid-type vehicle to the electric motor immediately before going into the tunnel on the intended travel position.

Detailed Description Text (60):
As described above, according to this embodiment, when it is judged that a tunnel exists at the intended travel position, drive source-controlling information is produced such that the drive source of the hybrid-type vehicle is switched to the electric motor immediately before traveling into the tunnel, and the drive source of the hybrid-type vehicle is switched to the electric motor by the drive source control section 2a immediately before going into the tunnel based on the produced drive source-controlling information. Thus, the vehicle can travel into the tunnel with the electric motor driven. For this reason, air within the tunnel can be prevented from being contaminated as opposed to the case where the engine is used to propel the vehicle through the tunnel.

Detailed Description Text (63):
The terminal device 10 judges whether a railroad crossing exists at the intended travel position based on the attribute of the position information of the intended travel position after the lapse of the predetermined time. When it judges that the railroad crossing exists on the intended travel position, the terminal device 10 produces gear-controlling information such that the gear is changed to a low-speed gear immediately before going into the railroad crossing so as to maintain the low-speed gear while passing through the railroad crossing without upshifting the transmission. The central control section 1 instructs the transmission control section 3 based on the gear-controlling information transferred from the terminal device 10 to change the gear to the low-speed gear immediately before going into the railroad crossing so as to maintain the low-speed gear during passing through the railroad crossing without upshifting.

Detailed Description Text (64):
As described above, according to this embodiment, when it is judged that the railroad crossing exists at the intended travel position, gear-controlling information is produced such that the gear is changed to the low-speed gear immediately before going into the railroad crossing so as to maintain the low-speed gear while passing through

the railroad crossing without upshifting, and the gear is changed to the low-speed gear by the transmission control section 3 immediately before going into the railroad crossing to maintain the low-speed gear while passing through the railroad crossing without changing up the gear based on the produced gear-controlling information. Thus, the vehicle can pass through the railroad crossing with the low-speed gear. For this reason, driving characteristics at the railroad crossing can be improved.

Detailed Description Text (65):
Similarly, when it is judged that a railroad crossing exists at the intended travel position based on the attribute of the position information of the intended travel position after the lapse of the predetermined time, suspension-controlling information is produced such that the suspension is controlled to increase a vehicle height immediately before going into the railroad crossing. The central control section 1 controls the suspension with the suspension control section 12 for increasing the vehicle height immediately before going into the railroad crossing. Thus, the vehicle can pass through the railroad crossing with the vehicle height increased. For this reason, the bottom of the vehicle can be prevented from striking the ground particularly when passing through a particularly bumpy railroad crossing.

Detailed Description Text (66):
Similarly, the terminal device 10 judges whether a railroad crossing exists at the intended travel position based on the attribute of the position information of the intended travel position after the lapse of the predetermined time. When it judges that the railroad crossing exists at the intended travel position, the terminal device 10 produces volume-controlling information such that the volume of the audio device is turned down immediately before going into the railroad crossing. The central control section 1 instructs the audio control device based on the volume-controlling information to turn down the volume of the audio device immediately before going into the railroad crossing.

Detailed Description Text (67):
As described above, according to this embodiment, when it is judged that the railroad crossing exists on the intended travel position, volume-controlling information is produced such that the volume of the audio device is turned down immediately before going into the railroad crossing, and the volume of the audio device is turned down by the audio control device 17 immediately before going into the railroad crossing based on the produced volume-controlling information. Thus, the vehicle can pass through the railroad crossing with the volume of the audio device turned down. For this reason, the sound of a signal in the railroad crossing can more surely be heard, whereby the vehicle can pass through the railroad crossing with greater safety.

Detailed Description Text (70):
The terminal device 10 extracts weather information corresponding to the position information of the present position and to the position information of the intended travel position after the lapse of the predetermined time based on the weather information which is transferred from the navigation system control section 4 to be received by the receive section 18, and compares the extracted weather information corresponding to the position information of the present position with the extracted weather information corresponding to the position information of the intended travel position to judge whether or not the weather conditions at the intended travel position are different from these of the present position. The terminal device 10, when it judges that the weather condition of the intended travel position is changed with respect to that of the present position, reads alarm information from the message storage section 11 and transfers it to the voice message notification section 9. The voice message notification section 9 provides the alarm information transferred from the terminal device 10 to the driver in the form of a voice message.

Detailed Description Text (71):
As described above, according to this embodiment, the weather information corresponding to the present position and the weather information corresponding to the intended travel position are extracted based on the received weather information, and when it is judged that the weather conditions at the intended travel position are different from the weather conditions at the present position, the alarm information read from the message storage section 11 is notified by the voice message notification section 18. Thus, when the weather conditions at the intended travel position are

different from these at the present position, the voice message notification section 9 can inform the matter of the driver. For this reason, the driver can learn the change of the weather conditions at the intended travel position with respect to the weather condition of the present position. For example, when it is clear before the tunnel and snowing beyond the tunnel, it becomes possible to instruct the driver to mount tire chains on the tires.

Detailed Description Text (72):
Next, the terminal device 10 extracts weather information corresponding to the position information of the intended travel position after the lapse of the predetermined time transferred from the navigation system control section 4 based on the weather information received by the receive section 18, and judges whether the extracted weather condition of the intended travel position is snow. The terminal device 10, when it judges that the weather condition of the intended travel position is snow, produces vehicle speed-controlling information such that the vehicle speed is reduced immediately before arriving at the intended travel position. The central control section 1 instructs the vehicle speed control section 13 based on the produced vehicle speed-controlling information to reduce the vehicle speed immediately before arriving at the intended travel position.

Detailed Description Text (73):
As described above, according to this embodiment, the weather information corresponding to the intended travel position is extracted based on the received weather information, and when it is judged that the extracted weather condition of the intended travel position is snow, vehicle speed-controlling information is produced such that the vehicle speed is reduced by the vehicle speed control section 13 immediately before arriving at the intended travel position based on the vehicle speed-controlling information. Thus, the vehicle can reduce speed in advance and then go on to a snowy road when it snows at the intended travel position. For this reason, safety can be improved. For example, when it is judged that the weather condition of the route after passing through the tunnel is snow, the vehicle speed can be reduced before exiting the tunnel to prepare for the snowy road.

Detailed Description Text (74):
Next, the terminal device 10 extracts weather information corresponding to the position information of the intended travel position after the lapse of the predetermined time transferred from the navigation system control section 4 based on the weather information received by the receive section 18, and judges whether the extracted weather condition of the intended travel position is snow. The terminal device 10, when it judges that the weather condition at the intended travel position is snow, produces suspension-controlling information such that the suspension is controlled to increase the vehicle height immediately before arriving at the intended travel position. The central control section 1 instructs the suspension control section 12 based on the produced suspension-controlling information transferred from the terminal device 10 to increase the vehicle height immediately before arriving at the intended travel position.

Detailed Description Text (75):
As described above, according to this embodiment, the weather information corresponding to the intended travel position is extracted based on the received weather information, and when it is judged that the extracted weather condition at the intended travel position is snow, suspension-controlling information is produced such that the suspension is controlled by the suspension control section 12 so as to increase the vehicle height immediately before arriving at the intended travel position based on the produced suspension-controlling information. Thus, the vehicle can increase its height in advance and then go on to a snowy road when it snows at the intended travel position. For this reason, safety can be improved. For example, when it is judged that the weather condition of the course after passing through the tunnel is snow, the vehicle height can be adjusted before going out of the tunnel to prepare for the snowy road.

CLAIMS:

1. A vehicle-mounted travel control system, comprising:

a navigation system control section which controls a storage section for storing map information inclusive of position information of a vehicle, a position detection section for detecting a present position of the vehicle, a course decision section for deciding an intended travel course of the vehicle, and in which position information of the present position of the vehicle is calculated by superimposing the position information detected by said position detection section onto the map information read out from said storage section;

a central control section for managing at least one subsystem control section based on information from a plurality of sensors installed in the vehicle, at least one of said sensors sensing an actual vehicle speed; and

a terminal device which is connected to said navigation system control section and said central control section, and which processes information from both of said navigation system control section and said central control section and transfers information to said navigation system control section and said central control section,

wherein said terminal device determines at least one predetermined time responsive to the actual vehicle speed based on actual vehicle speed information transferred from said central control section, and

wherein said navigation system control section determines an intended travel position where the vehicle will be after the lapse of the predetermined time based on the actual vehicle speed and the predetermined time transferred from said terminal device, and virtually advances a virtual position of the vehicle in a memory to the determined intended travel position.

3. A vehicle-mounted travel control system according to claim 1, wherein said navigation system control section is adapted to read out vehicle position information corresponding to said intended travel position from said storage section and to transfer said position information to said terminal device.

4. A vehicle-mounted travel control system according to claim 1, wherein said terminal device is adapted to judge whether a tunnel exists at the intended travel position based on the attribute of the position information of the intended travel position after said predetermined time has elapsed; and to produce control information to said at least one control section immediately before going into the tunnel at the intended travel position when it is judged that a tunnel exists at the intended travel position.

5. A vehicle-mounted travel control system according to claim 1, wherein said terminal device is adapted to judge whether a railroad crossing exists at the intended travel position based on the attribute of the position information of the intended travel position and to produce control information to at least one of controlling devices mounted on said vehicle immediately before going into the railroad crossing of the intended travel position when it is judged that the tunnel exists on the intended travel position.

6. A vehicle-mounted travel control system according to claim 1, wherein said navigation system control section is provide with a voice message notification section for providing a voice message, and a receive section for receiving weather information, wherein said terminal device is adapted to extract weather information corresponding to the position information of the present position and to the position information of the intended travel position based on the weather information received by said receive section, and to compare the extracted weather information corresponding to the present position with the extracted weather information corresponding to the intended travel position to judge whether the weather condition of the intended travel position is different from the weather condition of the present position; and to read out the alarm information and to transfer the alarm information to said voice message notification section when it is judged that the weather condition of the intended travel position is different from the weather condition of the present position, and

wherein said voice message notification section provides a driver with a voice message

advising the driver of the alarm information transferred from said terminal device.

7. A vehicle-mounted travel control system according to claim 1, wherein said terminal device is adapted to extract weather information corresponding to the position information of the intended travel position transferred from said navigation system control section based on the weather information received by said receive section, and to judge whether the weather condition of the intended travel position is snow; and to produce control information to at least one of said first control section and said second control section.

8. A control method for controlling operating systems of a vehicle having a vehicle-mounted travel control system, the travel control system including a navigation system control section which controls a storage section, a position detection section for detecting a present position of the vehicle, and a course decision section for deciding an intended travel course of the vehicle, and also including a central control section for managing at least one subsystem control section based on information from various sensors installed in the vehicle, at least one of the sensors sensing actual vehicle speed information; and also including a terminal device which is connected to said navigation system control section and said central control section, and which processes information from both said navigation system control section and said central control section and transfers the information to said navigation system control section and said central control section, said method comprising the steps of:

determining at least one predetermined time responsive to an actual vehicle speed based on the actual vehicle speed information transferred from said central control section,

determining an intended travel position, where the vehicle is expected to be after the predetermined time has elapsed, with reference to the present position of the vehicle based on the actual vehicle speed and predetermined time transferred from said terminal device, and

virtually advancing a virtual position of the vehicle in a memory to the determined intended travel position.

10. A method according to claim 8, further comprising

a step of judging whether a tunnel exists at the intended travel position based on an associated attribute of the position information of the intended travel position, and

a step of producing control information to said at least one of subsystem control section immediately before going into the tunnel at the intended travel position when it is judged that the tunnel exists at the intended travel position.

11. A method of according to claim 8, further comprising

a step of judging whether a railroad crossing exists at the intended travel position based on an associated attribute of the position information of the intended travel position, and

a step of producing control information to said at least one of subsystem control section immediately before going into the railroad crossing of the intended travel position when it is judged that a tunnel exists at the intended travel position.

12. A vehicle-mounted travel control system, comprising:

a storage storing map information, said map information including first information concerning a road for a vehicle and second information concerning a root landmark; and

a terminal device for determining an intended travel position at which said vehicle is expected to exist when said vehicle travels from a present position for a predetermined time, and for producing control information for controlling said vehicle based on said second information and said intended travel position before said vehicle

arrives at said intended position,

wherein said root landmark is a tunnel, and said terminal device produces said control information when said tunnel exists at said intended position.

15. A vehicle-mounted travel control system, comprising:

a storage storing map information, said map information including first information concerning a road for a vehicle and second information concerning a root landmark; and

a terminal device for determining an intended travel position at which said vehicle is expected to exist when said vehicle travels from a present position for a predetermined time, and for producing control information for controlling said vehicle based on said second information and said intended travel position before said vehicle arrives at said intended position,

wherein said root landmark is a railroad crossing, and said terminal device produces said control information when said railroad crossing exists at said intended position.

17. A vehicle-mounted travel control system, comprising:

a storage storing map information, said map information including weather information; and

a terminal device for determining an intended travel position at which said vehicle is expected to exist when said vehicle travels from a present position for a predetermined time, and for producing control information based on said weather information and said intended travel position before said vehicle arrives at said intended position.

18. A vehicle-mounted travel control system according to claim 17, further comprising a voice message notification section for providing alarm information, said alarm information being produced before said vehicle arrives at said intended position.

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DOCUMENT-IDENTIFIER: US 6546329 B2
TITLE: System for controlling drivetrain components to achieve fuel efficiency goals

Abstract Text (1):
A system for controlling a vehicle drivetrain in a fuel-efficient manner includes, in one embodiment, a control computer operable to determine a number of engine load/engine speed boundary conditions as functions of brake specific fuel consumption (BSFC) contours in relation to an engine output characteristics map and define therefrom an undesirable engine operation region U. As long as the engine is engaged with at least one of the gear ratios of the vehicle transmission, the control computer is operable to maintain or encourage engine operation outside of the region U. In another embodiment, the control computer is operable to define a contour from substantially zero engine load to substantially full engine load, wherein the contour preferably corresponds to a fuel-efficient path from no-load to full-load engine operating conditions. With change gear transmissions, the control computer is operable to control transmission shift points about the contour. With continuous variable transmissions, the control computer is operable to modify the effective gear ratio thereof to maintain engine operation on or about the contour. In either case, fuel efficient operation may be optimized.

Brief Summary Text (2):
The present invention relates generally to systems for electronically controlling and managing the operation of drivetrain components including internal combustion engines and change gear transmissions, and more specifically to such systems for controlling such drivetrain components during gear shifting operations.

Brief Summary Text (8):
What is therefore needed is a system for controlling drivetrain components, which may include an internal combustion engine and a change gear transmission, to thereby achieve desired fuel economy goals while also allowing for additional engine output only when the need therefore legitimately exists.

Drawing Description Text (28):
FIG. 25A is a flowchart illustrating one preferred embodiment of a software algorithm for executing the gear change routine of step 328 of FIG. 24.

Drawing Description Text (29):
FIG. 25B is a flowchart illustrating an alternate embodiment of a software algorithm for executing the gear change routine of step 328 of FIG. 24.

Drawing Description Text (30):
FIG. 25C is a flowchart illustrating another alternate embodiment of a software algorithm for executing the gear change routine of step 328 of FIG. 24.

Detailed Description Text (5):
A number of sensors and actuators permit control computer 20 to interface with some of the various components of system 25 as well as other vehicle and/or engine systems. For example, engine 22 includes an engine speed sensor 26 which is electrically connected to input IN2 of control computer 20 via signal path 28. Engine speed sensor 26 is preferably a known Hall-effect device operable to sense speed and/or position of a toothed gear rotating synchronously with the engine crank shaft. However, the present invention contemplates using any known engine speed sensor 26, such a variable

reluctance sensor or the like, which is operable to sense engine rotational speed and provide a signal to control computer 20 corresponding thereto.

Detailed Description Text (9):
An accelerator pedal 34 preferably includes an accelerator pedal position or deflection sensor 36 that is electrically connected to input IN1 of control computer 20 via signal path 38. Sensor 36 is, in one preferred embodiment, a potentiometer electrically connected to a suitable voltage and-having a wiper that is electrically connected to signal path 38 and mechanically connected to pedal 34 so that the voltage on signal path 38 corresponds directly to the position, or deflection, of the accelerator pedal 34. The present invention further contemplates that other known sensors may be alternatively associated with accelerator pedal 34 to provide one or more analog and/or digital signals corresponding to accelerator pedal position or pressure applied to pedal 34. In any event, such a sensor is operable to provide control computer 20 with an accelerator pedal signal indicative of driver requested torque.

Detailed Description Text (19):
In accordance with this engine acceleration limiting scheme, drivers are thus provided with the ability to operate the engine 22 at higher engine acceleration values, and correspondingly higher engine output torque levels, as the vehicle speed increases. This type of engine acceleration limiting scheme is provided along with the engine speed limiting scheme just described in order to discourage vehicle operators from attempting to defeat the engine speed limiting scheme. One way to defeat a strictly engine load-based engine speed limiting scheme such as that just described is to command high engine load (e.g. by commanding a high accelerator pedal position) to thereby trick control computer 20' into providing a higher engine speed limit (ESL) than would otherwise be necessary for acceptable shiftability on level road surfaces. By commanding 100% accelerator pedal position following each gear shift, vehicle operators could accordingly have the maximum engine speed limit available to them at all times. The engine acceleration limiting scheme just described thus provides a check on the engine speed limiting scheme by limiting engine acceleration to appropriate engine acceleration values within specific vehicle speed ranges. Vehicle operators attempting to defeat the engine speed limiting feature as just described will be unable to effectively do so since control computer 20 will limit engine acceleration to a suitable rate depending upon vehicle speed, and thereby disallow an increase in the engine speed limit (ESL) unless engine load is truly high due to road conditions and/or excessive vehicle mass.

Detailed Description Text (39):
A number of sensors and actuators permit control computer 202 to interface with some of the various components of system 200 as well as other vehicle and/or engine systems. For example, engine 206 includes an engine speed sensor 218, which is electrically connected to input IN3 of control computer 202 via signal path 220. Engine speed sensor 218 is preferably a known Hall-effect device operable to sense speed and/or position of a toothed gear rotating synchronously with the engine crankshaft. However, the present invention contemplates using any known engine speed sensor 218, such a variable reluctance sensor or the like, which is operable to sense engine rotational speed and provide a signal to control computer 200 corresponding thereto.

Detailed Description Text (43):
An accelerator pedal preferably includes an accelerator pedal position or deflection sensor 212 that is electrically connected to input IN1 of control computer 202 via signal path 214. Sensor 212 is, in one preferred embodiment, a potentiometer electrically connected to a suitable voltage and having a wiper that is electrically connected to signal path 214 and mechanically connected to the accelerator pedal so that the voltage on signal path 214 corresponds directly to the position, or deflection, of the accelerator pedal. The present invention further contemplates that sensor 212 may alternatively be any known sensor operatively associated with the accelerator pedal to provide one or more analog and/or digital signals corresponding to accelerator pedal position or pressure applied to the pedal. In any event, such a sensor is operable to provide control computer 202 with an accelerator pedal signal indicative of driver requested torque. The accelerator pedal further preferably includes an idle validation switch (IVS) that is electrically connected to input IN2

of control computer 202 via signal path 216. IVS may alternatively be replaced with a suitable sensor or other electrical component, the importance of any such switch, sensor or component lying in its ability to distinguish between an undeflected accelerator pedal (e.g., 0% throttle) and a deflected accelerator pedal (e.g., greater than 0% throttle) and provide a signal corresponding thereto to input IN2 of control computer 202.

Detailed Description Text (46):
System 200 further optionally includes a global positioning system (GPS) receiver 250 operable to receive geographical coordinate data relating to a present location of receiver 250 from a number of earth-orbiting satellites, as is known in the art. The geographical coordinate data may include, for example, latitudinal, longitudinal and altitudinal coordinates, as well as time of day information. In any case, receiver 250 is operable, in one embodiment, to supply any combination of the raw geographical coordinate data to input IN6 of control computer 202 via signal path 252 (shown in phantom), whereby control computer 202 is thereafter operable to convert the raw geographical coordinate data to useful geographical location data in accordance with known techniques. Alternatively, receiver 250 may include signal processing capability whereby receiver 250 is operable to receive the raw geographical coordinate data, convert this data to useful geographical location data, and provide such data to control computer 202 via signal path 252. Alternatively still, the present invention contemplates that the interface module 246 may be configured to include the GPS receiver 250, whereby module 246 is operable to supply control computer 202 with either the raw geographical coordinate data or the actual geographical location data.

Detailed Description Text (47):
System 200 further optionally includes a signal transceiver 254 that is electrically connected to an input/output port I/O4 of control computer 202 via signal path 256 (shown in phantom), wherein signal path 256 may include any number of signal conduction paths. In one embodiment, transceiver 254 is a cellular telephone transceiver, whereby control computer 202 is operable to communicate with a remote location via a cellular network, as is known in the art. Alternatively, signal transceiver 254 may be a radio frequency transceiver, whereby control computer 202 is operable to communicate with a remote location via a radio or microwave frequency link. It is to be understood that the present invention contemplates that the signal transceiver 254 may alternatively be any signal transceiver capable of conducting one or two-way communications with a remote source via a wireless communication link.

Detailed Description Text (53):
In accordance with the present invention, the number of boundaries may be variable and may be defined according to a number of preferred techniques as will be described in greater detail hereinafter. Similarly, control of engine 206 to maintain or encourage operation outside of the undesirable engine operating region U may be accomplished according to a number of preferred techniques, and a number of preferred operating or other conditions may be recognized by control computer 202 to temporarily override such control, all of which will be described in greater detail hereinafter. In any case, the present invention also contemplates a number of techniques for establishing or defining the number of boundaries. For example, such boundaries may form part of an original engine calibration whereby such boundaries are stored in memory 204 of control computer 202. Preferably, the boundaries residing in memory 204 may thereafter be adjusted or "trimmed" via service/recalibration tool 258. Alternatively, the boundaries may be established or defined entirely via service/recalibration tool 258, whereby such boundaries are stored in memory 204. Alternatively still, the boundaries may be established/defined and/or modified as a function of external information, such as GPS receiver 252, signal transceiver 254, and the like, as will be more fully described hereinafter.

Detailed Description Text (59):
In still another alternative embodiment of algorithm 350, process boxes 354, 356, 366 and 368 may be omitted in lieu of, or be supplemented by, process box 370 (also shown in phantom). Process box 370 includes step 372 wherein control computer 202 is operable to determine a current vehicle position. In one embodiment, control computer 202 is operable to determine current vehicle position via information received from GPS receiver 252. As described hereinabove, such information received from GPS receiver 252 may be either geographical position coordinates or data from which such

coordinates can be determined. Alternatively, interface module 246 may include a GPS receiver and auxiliary computer operable to determine current vehicle position information and provide such information to control computer 202 via signal path 248. Alternatively still, one or more external systems in the proximity of the vehicle carrying system 200 may be operable to transmit information to control computer 202 (e.g., via signal transceiver 254) from which control computer 202 may determine, or at least estimate, current vehicle position. The present invention contemplates that other known position determining systems maybe used, either as part of system 200 or remote therefrom, to determine a current vehicle position for the purposes of step 372. In any case, algorithm execution continues from step 372 at step 374 where control computer 202 is operable to determine boundaries B1 and B2, and optionally B3, as a function of current vehicle position. In one embodiment, control computer 202 is operable to execute step 374 by comparing current vehicle position to geographical position data stored in memory, and defining boundaries B1 and B2, and optionally B3, as a function thereof. Alternatively, control computer may be operable at step 374 to transmit via signal transceiver 254 the current vehicle position to a remote computer, whereby the remote computer is operable to make appropriate boundary determinations based thereon and transmit either boundary information, or other information from which such boundary information can be determined, back to control computer 202 via signal transceiver 254. In any case, process box 370 provides for the ability to modify the location and shape of the undesirable engine operation region U relative to the horsepower curve 262 depending upon the current location of the vehicle. For example, fuel efficiency goals may be different depending upon the jurisdiction (e.g., country, state, county, etc.) in which the vehicle is traveling, the topography of the region (e.g., flat vs. hilly terrain) in which the vehicle is traveling, population density of the region (e.g., urban vs. rural) in which the vehicle is traveling, and the like. Process box 370 allows any such changing fuel efficiency goals to be met without interrupting vehicle operation.

Detailed Description Text (60):
Regardless of the manner in which boundaries B1 and B2, and optionally B3, are determined, algorithm 350 may further optionally includes process box 376 to which process box 368 or 370 advance. Process box 376 includes step 378 wherein control computer 202 is operable to determine a presently engaged gear ratio (GR) or a current vehicle speed (VS). The presently engaged gear ratio may be determined by any known means, such as via a ratio of engine speed and vehicle speed, for example, and vehicle speed is preferably determined via information provided by vehicle speed sensor 230. In any case, algorithm execution continues from step 378 at step 380 where control computer 202 is operable to modify boundaries B1 and/or B2 as a function of either the presently engaged gear ratio GR or current vehicle speed VS. In one embodiment, control computer 202 is operable at step 380 to downwardly. adjust the location of boundary B2 toward the horizontal engine speed axis, and/or to rightwardly adjust the location of boundary B1 away from the vertical horsepower axis, as a function of GR or VS to thereby decrease the undesirable operation region U (and correspondingly expand the permissible engine operating region) when the need therefore exists in order to perform/complete certain gear shifting operations. For example, under some gear ratio and/or vehicle speed conditions, the optimal upshift point to the next higher gear may be located within region U near the existing B1 and/or B2 boundaries. Under such conditions, process box 376 provides for the ability to adjust B2 downwardly, or to adjust B1 rightwardly, to thereby allow the pending upshift to be performed/completed at a predefined shift point. Those skilled in the art will recognize other gear ratio/vehicle speed-based conditions wherein alteration of the location and/or slope of either, or both, of B1 and B2 is desirable, and that B1 and/or B2 boundary alterations based on such conditions are intended to fall within the scope of the present invention.

Detailed Description Text (61):
Algorithm execution continues from process box 376 at step 382 wherein control computer 202 is operable to determine whether a driver reward or driver penalty is currently available. Preferably, a driver reward or penalty is determined as a function of the driver's operational history, and one example of a system for determining driver rewards/penalties is described in U.S. Pat. No. 5,954,617 to Horgan et al., which is assigned to the assignee of the present invention and the contents of which are incorporated herein by reference. In one embodiment, control computer 202 is operable to maintain driver reward/penalty information and therefore make an automatic

determination at step 382 as to whether such a reward/penalty is available. Alternatively, interface module 246 may include an auxiliary computer operable to maintain driver reward/penalty information, wherein control computer 202 is operable at step 382 to determine whether a driver reward/penalty is available based on information supplied thereto from interface module 246. Alternatively still, in the case of a driver reward, such a reward, if available, may be invoked at will by the vehicle operator via selection of appropriate keys or buttons forming part of interface module 246. In such a case, control computer 202 is operable at step 382 to determine whether a driver reward is available based on information supplied thereto from interface module 246 as a result of any such vehicle operator action. In any case, if control computer 202 determines at step 382 that a driver reward or penalty is currently available, algorithm execution continues at step 384 where control computer 202 is operable to modify boundaries B1 and B2, and optionally B3, according to the driver reward or penalty. For example, if a driver reward is available, control computer 202 may be operable at step 384 to either move the location, or otherwise alter the shape/slope, of any one or more of the boundaries B1, B2 and B3, or to alternatively decrease the total area of region U, so as to provide the driver with an expanded engine operating range for some desired time period or traveling distance. Conversely, if a driver penalty is available, control computer 202 may be operable at step 384 to suitably alter the shape/location of any of B1, B2, B3 or to increase the total area of region U, so as to provide the driver with a restricted engine operating range for some desired time period or traveling distance. In either case, algorithm execution continues from step 384 and from the "no" branch of step 382 to step 386 where algorithm execution is returned to step 304 of algorithm 300 (FIG. 14).

Detailed Description Text (69):
Referring again to FIG. 14, algorithm 300 advances from step 314 to step 316 where control computer 202 is operable to execute and engine control (EC) override routine. The present invention recognizes that there may be some operational conditions wherein it would be desirable to disable or modify, at least temporarily, execution of the engine control (EC) routine of step 314. Referring to FIGS. 19A and 19B, one preferred embodiment of a software algorithm 500 for executing step 316 of algorithm 300, in accordance with the present invention, is shown. Algorithm 500 begins at step 502 and at step 504, control computer 202 is operable to determine whether an autoshift feature is active. In embodiments of system 200 wherein transmission 208 includes automatically selectable gear ratios and wherein shifting between such gears is controlled by a transmission control module 242, such an autoshift feature will be active. For all manually selectable gear ratios and gear shifting controlled by control computer 202, such an autoshift feature will be inactive. In any case, if control computer 202 determines at step 504 that the autoshift feature is active, algorithm execution advances to step 506 where control computer 202 is operable to determine whether an automatic upshift is currently pending. Preferably, control computer 202 is operable to execute step 506 by monitoring signal line 244, whereby transmission control module 242 is operable, as is known in the art, to broadcast such gear shifting information. If, at step 506, control computer 202 determines that an autoshift is indeed pending, algorithm execution advances to step 508 where control computer 202 is operable to compare a so-called "low load (LL) upshift point" with the currently limited engine speed, i.e., engine speed limited by engine control (EC) routine of step 314 of algorithm 300. Preferably, information relating to the LL upshift point of the particular gear ratio currently being upshifted to is broadcast by transmission control module 246 onto data link 244 or is otherwise supplied to control computer 202. If, at step 508, control computer 202 determines that the LL upshift point is indeed greater than the currently limited engine speed, algorithm advances to step 510 where control computer 202 is operable to disable the engine control (EC) routine of step 314, thereby providing for default engine operating conditions whereby engine speed will be allowed to increase to/through the LL upshift point. Alternatively, control computer 202 may be operable at step 510 to temporarily modify boundary B1 and/or boundary B2 to thereby provide for engine operating conditions whereby engine speed will be allowed to increase to/through the LL upshift point. In any case, algorithm execution advances from step 510 to step 512 where control computer 202 is operable to monitor transmission module 246 for an indication of whether the pending automatic upshift is complete. If not, step 512 loops back to step 510. If, at step 512, control computer 202 determines that the automatic upshift is complete, algorithm execution advances to step 514 where control computer 202 is operable to resume the engine control (EC) routine of step 314 of algorithm 300.

Algorithm execution advances from step 514, as well as from the "no" branches of steps 504, 506 and 508, to step 516.

Detailed Description Text (70):
At step 516, control computer 202 is operable to determine whether a GPS feature is active. Preferably, if system 200 includes a GPS receiver 250 and/or if interface module 246 includes a GPS receiver, then the GPS feature will be active. Otherwise, the GPS feature will be inactive. In any case, if control computer 202 determines at step 516 that the GPS feature is active, algorithm execution advances to step 518 where control computer 202 is operable to determine whether a change in engine control (EC) routine operational status is warranted based on current GPS coordinates. For example, if at step 518, the engine control (EC) routine of step 314 of algorithm 300 is currently executing and control computer 202 determines from the GPS coordinates that the current position of the vehicle carrying system 200 does not necessitate continued execution of the EC routine, control computer 202 is operable to set an engine control routine operational status indicator to an active status. If, on the other hand, control computer 202 determines in the foregoing scenario that continued execution of the EC routine is warranted, control computer 202 is operable at step 518 to set the engine control routine operational status indicator to an inactive status. Thereafter at step 520, control computer 202 is operable to determine whether the EC routine operational status indicator is active. If so, algorithm execution advances to step 522 where control computer 202 is operable to disable the engine control (EC) routine of step 314 of algorithm 300. Algorithm execution advances therefrom, as well as from the "no" branch of step 520, to step 524.

Detailed Description Text (71):
From the foregoing, it should be apparent that steps 516-522 are included to provide for the ability to disable the engine control (EC) routine of step 314 of algorithm 300 based on current vehicle position. For example, the EC routine may be executing when the vehicle is traveling in one jurisdiction (e.g., country, state, county, etc.), topographical region (e.g., mountainous, hilly or flat terrain), geographical region (e.g., urban or rural) or the like, and may thereafter be disabled pursuant to steps 516-522 of algorithm 500 when the vehicle leaves the current jurisdiction, topographical region, geographical region or the like, and enters a different jurisdiction, topographical region, geographical region or the like. Those skilled in the art will recognize other vehicle position-based conditions wherein it may be desirable to disable a currently executing EC routine, and that any other such conditions are intended to fall within the scope of the present invention.

Detailed Description Text (74):
Algorithm execution advances from step 530, as well as from the "no" branches of steps 524 and 538, to step 532 where control computer 202 is operable to determine whether a grade indicator feature, in accordance with another aspect of the present invention, is active. Preferably, the grade indicator feature is active at all times, although the present invention contemplates activating the grade indicator feature only in geographical regions wherein road grade changes are prevalent, wherein any known technique for making this determination may be used including known GPS techniques, known engine/vehicle operating condition identification techniques, and the like. In any case, if control computer 202 determines at step 532 that the grade indicator feature is active, algorithm execution advances to step 534 where control computer 202 is operable to execute a grade indicator routine in accordance with another aspect of the present invention. Thereafter at step 536, control computer 202 is operable to determine whether a positive grade indicator was set during execution of the grade indicator routine of step 534. If so, algorithm execution continues at step 538 where control computer 202 is operable to modify the engine control (EC) routine of step 314 by allowing for increased engine performance as long as the positive grade indicator is set. From step 538, and from the "NO" branch of step 536, algorithm execution continues at step 540 where algorithm 500 is returned to its calling routine.

Detailed Description Text (85):
Referring again to FIG. 14, execution of algorithm 300 advances from step 316 to step 318 where control computer 202 is operable to determine whether any new or updated load/speed boundary information is available. For example, if system 200 includes GPS system 250, signal transceiver 254 and/or interface module 246, new load/speed boundary data may be available via any one or more of these sources. If such new or

updated load/speed data is available, algorithm execution loops back to step 304. Otherwise, algorithm execution loops back to step 306.

Detailed Description Text (87):
If, at step 320, control computer 202 determines that a gear shift is not currently in process, algorithm advances to step 326 where control computer 202 is operable to determine whether the downshift flag is set. If not, algorithm execution advances to step 330. If, at step 326, control computer 202 determines that the downshift flag is set, then a downshift has just recently been completed and algorithm execution advances to step 328 wherein control computer 202 is operable to execute a gear change routine and reset the downshift flag. Thereafter at step 330, control computer is operable to determine engine output conditions (EOC) and execute the engine control routine (EC), preferably as described with respect to steps 306 and 314 of algorithm 300 (FIG. 14). Thereafter at step 318, control computer 202 is operable to determine whether new load/speed boundary data is available as described with respect to FIG. 14. If so, algorithm execution loops back to step 304, and if not, algorithm execution loops back to step 310.

Detailed Description Text (88):
From the foregoing, it should now be apparent that algorithm 300' provides an enhancement to algorithm 300 of FIG. 14 in that rather than reestablishing the engine control routine (EC) immediately following a transmission downshift as with algorithm 300, algorithm 300' executes a gear change routine after a transmission downshift and prior to reestablishing the engine control routine (EC). The gear change routine of step 328 may be carried out in a number of ways, and three embodiments therefore will be described in detail hereinafter with respect to FIGS. 25A-25C. However, a common theme to any such routine is that the engine control routine preferably should not be reestablished immediately following a transmission downshift since engine load and engine speed may both be substantially increased as a result of the downshift. While such operating conditions just following a downshift may fall to the right (i.e., at greater engine speeds) of boundary B1, they may also fall above (i.e., at a higher engine load or throttle percentage) boundary B2 and therefore outside the region, U, of undesirable operation. If a decision of whether to reestablish the engine control routine (EC) is made with regard to such operating conditions immediately following a downshift, control computer 202 will disable the EC routine only to immediately reestablish the EC routine if operating conditions fall back into the region, U, of undesirable operation as may often be the case after engine operation has stabilized following a typical downshift. The intent of the gear change routine of the present invention is thus to avoid uncertainty regarding whether to reestablish or disable the engine control routine (EC) following a transmission downshift. In any case, the gear change routine of step 328 of FIG. 24 is preferably stored within memory 204 and is executed by control computer 202. Alternatively, the gear change algorithm could be executed by an auxiliary control computer within transmission control module 242, wherein instructions as to whether to reestablish or disable the engine control routine (EC), as well as the timing thereof, may be communicated to control computer 202 via communication link 244.

Detailed Description Text (89):
Referring now to FIG. 25A, a flowchart is shown illustrating one preferred embodiment of a software algorithm 640 for executing the gear change routine of step 328 of algorithm 300'. Algorithm 640 begins at step 642 and at step 644, control computer 202 is operable to delay for a predefine time period before advancing to step 646 where algorithm 640 returns to step 328 of algorithm 300' of FIG. 24. With algorithm 640, control computer 202 is accordingly operable in the execution of algorithm 300' to delay for a predefined time period following a transmission downshift to thereby allow engine operating conditions to settle prior to making a decision as to whether to reestablish or disable the engine control (EC) routine. In one embodiment, the predefined delay is approximately 2-3 seconds, although the present invention contemplates providing any desired delay period.

Detailed Description Text (90):
Referring now to FIG. 25B, a flowchart is shown illustrating an alternate embodiment of a software algorithm 650 for executing the gear change routine of step 328 of algorithm 300'. Algorithm 650 begins at step 651 and at step 652, control computer 202 is operable to determine an average rate of change of commanded throttle (CT.sub.ROC).

Preferably, control computer 202 is operable to determine CT.sub.ROC by processing the accelerator pedal signal on signal path 214 according to well-known equations. Thereafter at step 653, control computer 202 is operable to set a time delay parameter T.sub.D as a function of CT.sub.ROC. In one preferred embodiment, control computer 202 is operable at step 653 to compare CT.sub.ROC with a threshold CT.sub.ROC value. If CT.sub.ROC is below the threshold CT.sub.ROC value control computer 202 is operable to set the time delay parameter T.sub.D to a high time value, whereas if CT.sub.ROC is at or above the threshold value control computer 202 is operable to set the time delay parameter T.sub.D to a low time value. In an alternate embodiment, control computer 202 is operable at step 653 to define T.sub.D as a continuous function that is inversely proportional to CT.sub.ROC. Thus, as CT.sub.ROC increases in this embodiment, T.sub.D decreases. In any case, algorithm execution advances from step 653 to step 654 where control computer 202 is operable to reset a timer parameter (T) to an arbitrary value; e.g., zero, and thereafter at step 655 control computer 202 is operable to compare the timer parameter, T, to the time delay value T.sub.D. If, at step 655, T is less than or equal to T.sub.D, algorithm execution loops back to step 655. If, on the other hand, control computer 202 determines at step 655 that T has exceeded T.sub.D, algorithm execution advances to step 656 where algorithm 650 is returned to step 328 of algorithm 300' of FIG. 24. This technique allows the engine operating conditions to advance closer to steady state before deciding whether to reestablish or disable the engine control (EC) routine by delaying for a definable time period following a downshift. In this embodiment, the time delay is a function of the average rate of change of commanded throttle. If a vehicle operator quickly accelerates after a downshift, this time delay will be generally short since steady state (or near-steady state) conditions will be achieved quickly. However, if the vehicle operator slowly accelerates after a downshift, this time delay will be longer since it will generally take longer to achieve steady state (or near-steady state) conditions.

Detailed Description Text (91):
Referring now to FIG. 25C, a flowchart is shown illustrating another alternate embodiment of a software algorithm 660 for executing the gear change routine of step 328 of algorithm 300'. Algorithm 660 begins at step 662 and at step 664, control computer 202 is operable to monitor engine load (EL) or throttle percentage (%THR). Thereafter at step 666, control computer 202 is operable to compare EL or %THR with a threshold value TH. If EL or %THR is above TH, algorithm execution advances to step 668 where control computer 202 is operable to compute a running engine load average EL.sub.AV of either EL or %THR. Preferably, control computer 202 is operable to compute the running average over a recent time interval, wherein the length of the time interval may be set as desired. Thereafter at step 668, algorithm execution loops back to step 664.

Detailed Description Text (97):
As with the embodiment described and illustrated with respect to FIGS. 13-19; the number of boundaries in this embodiment may be variable and may be defined according to a number of preferred techniques as will be described in greater. detail hereinafter. Similarly, control of engine 206 to maintain or encourage operation outside of the undesirable engine operating region U may be accomplished according to a number of preferred techniques, and a number of preferred operating or other conditions may be recognized by control computer 202 to temporarily override such control, all of which has been or will be described in greater detail herein. In any case, the present invention also contemplates a number of techniques for establishing or defining the number of boundaries. For example, such boundaries may form part of an original engine calibration whereby such boundaries are stored in memory 204 of control computer 202. Preferably, the boundaries residing in memory 204 may thereafter be adjusted or "trimmed" via service/recalibration tool 258. Alternatively, the boundaries may be established or defined entirely via service/recalibration tool 258, whereby such boundaries are stored in memory 204. Alternatively still, the boundaries may be established/defined and/or modified as a function of external information, such as GPS receiver 252, signal transceiver 254, and the like, as described hereinabove with respect to FIGS. 13-19.

Detailed Description Text (108):
At step 812, control computer 202 is operable to determine whether the engine operating conditions (EOC) determined at step 806 indicate that engine operation is

approaching contour C from the right; i.e., engine speed decreasing with present engine speed and load greater than contour C. If so, algorithm execution advances to step 814 where control computer 202 is operable to execute a downshift routine and advance to step 816 of algorithm 800. If, on the other hand, control computer 202 determines at step 812 that EOC is not approaching contour C from the right, algorithm advances to step 816 where control computer 202 is operable to determine whether a new load/speed contour, or data relating thereto, is available. For example, if system 200 (FIG. 12) includes GPS system 250, signal transceiver 254 and/or interface module 246, new load/speed contour data may be available via any one or more of these sources. If such new or updated load/speed contour data is available at step 816, algorithm execution loops back to step, 804. Otherwise, algorithm execution loops back to step 806. Those skilled in the art will recognize that algorithm 800 may be readily adapted to an embodiment wherein transmission 208 is a CVT by omitting steps 812 and 814, and by modifying steps 808 and 810. In this embodiment, for example, control computer 202 is operable at step 808 to determine whether EOC is on (or within some predefined engine speed difference of) contour C. If so, algorithm execution advances to step 816. If, on the other hand, control computer 202 determines at step 808 that EOC is. not on (or near) contour C, control computer 202 is operable to instruct the auxiliary computer within transmission control module 242 to adjust the effective gear ratio of CVT 208, in a manner known in the art, to thereby maintain EOC on (or near) contour C.

Detailed Description Text (110):
From step 836, algorithm execution advances to step 838 where control computer 202 is operable to determine a gear step (GS) from the presently engaged transmission gear to the next numerically higher transmission gear. In one embodiment, the various gear steps of transmission 208 are stored in memory 204, or in a similar memory unit within transmission control module 242. In an alternative embodiment, control computer 202 is operable to periodically learn the various gear steps of transmission 208, preferably by periodically computing such steps as a function of engine and tailshaft speeds, or by other known techniques, during normal shifting operations and then storing the learned gear steps in memory. In either case, control computer 202 is accordingly operable to determine GS at step 838 by determining a presently engaged transmission gear (preferably via a ratio of engine and tailshaft speeds or other known technique) and then by retrieving a corresponding gear step to the next numerically higher transmission gear from memory.

Detailed Description Text (122):
From step 876, algorithm execution advances to step 878 where control computer 202 is operable to determine a gear step (GS) from the presently engaged transmission gear to the next numerically lower transmission gear. In one embodiment, the various gear steps of transmission 208 are stored in memory 204, or in a similar memory unit within transmission control module 242. In an alternative embodiment, control computer 202 is operable to periodically learn the various gear steps of transmission 208, preferably by periodically computing such steps as a function of engine and tailshaft speeds, or by other known techniques, during normal shifting operations and then storing the learned gear steps in memory. In either case, control computer 202 is accordingly operable to determine GS at step 878 by determining a presently engaged transmission gear (preferably via a ratio of engine and tailshaft speeds or other known technique) and then by retrieving a corresponding gear step to the next numerically lower transmission gear from memory.

CLAIMS:

10. The system of claim 1 further including: means for establishing a driver reward/penalty; and means for modifying an area or location of said region relative to said engine output characteristics map as a function of said driver reward/penalty.

11. The system of claim 1 further including: means for determining a currently engaged gear ratio of a transmission coupled to an engine included within a vehicle drivetrain and producing a gear ratio value corresponding thereto; means for determining vehicle speed of a vehicle carrying said engine and producing a vehicle speed signal corresponding thereto; and means for modifying an area or location of said region relative to said engine output characteristics map as a function of one of said currently engaged gear ratio value and said vehicle speed signal.

12. The system of claim 1 further including: means for determining current vehicle position of a vehicle carrying an engine forming part of a vehicle drivetrain; and means for defining an area or location of said region relative to said engine output characteristics map as a function of said current vehicle position.

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Set Name side by side	Query	Hit Count	Set Name result set
DB=USPT; PLUR=YES; OP=ADJ			
L13	L12 and l11	6	L13
L12	learn$3 same (l3 or l5)	9434	L12
L11	l8 not L10	24	L11
L10	L9 and l8	1	L10
L9	fuzzy	7719	L9
L8	L7 and l6	25	L8
L7	l4 and l1	621	L7
L6	L5 and l2	27484	L6
L5	position or location	1998850	L5
L4	L3 near (monitor$ or sens$3 or detect$3)	11611	L4
L3	transmission	487697	L3
L2	navigation or gps	33082	L2
L1	(adjust$3 or chang$3) near (shift$4 or gear)	19319	L1

END OF SEARCH HISTORY